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Regula Philippi Arrhidaei

La lettre apocryphe de DENYS L'ARÉOPAGITE au philosophe APOLLOPHANE qu'au IX^e^ siècle le moine HILDUIN, faussaire émérite, a insérée dans sa biographie du saint, raconte que celui-ci se trouvant à Héliopolis de Syrie, vit le soleil s'obscurcir et constata que cette éclipse se produisait à un moment où elle ne pouvait être attendue : « *Ut purgatum*, dit le texte, *rediit Solis diametrum, regulam Philippi Aridaei adsumpsimus ; cumque repperimus, quod erat notissimum, eo tenus fatigatione ecliptica solem pati molestias non debere* » etc. (1)

Le Père G. THÉRY, qui a étudié de très près toute la légende du ou plutôt des saints DENYS avec la littérature qui s'y rattache (2) et spécialement la lettre à APOLLOPHANE, a bien voulu m'écrire que selon ses conclusions, cette lettre a été d'abord composée en grec par un moine byzantin de l'abbaye de Saint-Denis. Elle n'est mentionnée dans aucune source grecque avant l'année 835 et sa version latine n'a été connue par aucun des traducteurs ou commentateurs de l'Aréopagite qui nous sont parvenus.

Un titre d'ouvrage transmis uniquement par une traduction d'un document grec apocryphe du IX^e^ siècle est certainement sujet à caution et l'autorité qu'on peut attribuer à la citation qu'en fait la prétendue lettre de DENYS est bien faible. Néanmoins il paraît invraisemblable que le moine qui est l'auteur de cette supercherie, ait simplement tiré de son imagination cette « *regula*

(1) *Vita S. Dionysii auctore Hilduino*, c. 14 (P.L., CVI, p. 33C). Autre rédaction P. G. III 1122 = AA.SS. Oct. IV, p. 774D : « Cum enim totus orbis tetra tenebrarum caligine uniformiter obductus fuisset ac iam repurgari solis globus et renitescere accepisset [l. coepisset ?], tum assumpta Philippi Aridaei regula et contemplatis caeli orbibus deprehendimus, quod erat quoque alias notissimum, non potuisse id temporis defectionem caeli evenire. » Notre attention a été attirée d'abord sur ces textes par M^e^ la Marquise de MAILLÉ, que nous remercions vivement de nous les avoir fait connaître.

(2) Cf. *Comptes rendus Acad. Inscr.*, 1934, p. 276 sq.

Philippi Aridaei » qu'il invoque comme si elle était bien connue. Comment aurait-il songé à introduire ici ce roi de Macédoine qu'on n'attendait guère en une telle conjoncture ?

Selon le Père THÉRY c'est probablement de la même officine de moines byzantins en rapport avec l'abbaye de Saint-Denis qu'est sortie aussi une « autobiographie » de l'Aréopagite, apparentée à l'épître à APOLLOPHANE. Rédigée en grec, elle ne s'est pas conservée sous sa forme originale mais seulement dans des versions orientales (3) : DENYS dans sa jeunesse s'instruit à Athènes et après avoir étudié les révolutions des astres, il est jugé digne de recevoir communication du « Livre des sphères, celui que les Grecs appellent livre de l'astronomie ». C'est encore ce fabuleux « Livre des sphères » ou de l'astronomie que le saint consulte à Héliopolis après avoir été le spectateur terrifié de l'occultation du soleil, et il y trouve la révélation que ce phénomène insolite et inexplicable a été déterminé par la Crucifixion du Christ (4). On a l'impression que le traducteur oriental a ici substitué un vague titre anonyme, celui de « Livre des sphères », à un autre plus précis, que donnait sa source mais qui eut été incompréhensible pour ses lecteurs syriens.

L'histoire du miracle d'Héliopolis est relativement ancienne. Il est fait une allusion très précise aux circonstances où l'éclipse se produisit dans la « Lettre à POLYCARPE » (5), qui fait partie

(3) Publiée en syriaque d'après une double recension par M. A. KUGENER, *Oriens Christianus*, 1907, p. 292 ss. On en connaît aussi des versions en copte, en arménien et en arabe. Cf. PEETERS, *Analecta Bollandiana*, XXIX, 1910, p. 302 ss. M. KUGENER croyait que le texte syriaque était l'original, mais le Père PEETERS semble avoir démontré que toutes les traductions orientales dérivent d'une source grecque aujourd'hui perdue.

(4) KUGENER, *l. c.*, p. 209: « Lorsque les prêtres (d'Athènes) virent que j'étais arrivé à la perfection dans la science des calculs, ils prièrent tous les philosophes de mettre entre mes mains le Livre des Sphères, celui de l'Astronomie [*recension* A : les Grecs l'appellent dans leur langue (livre) de l'astronomie]. » P. 329 : « Frappé de stupeur en recherchant pour quelle cause le soleil s'était obscurci, alors qu'aucun des cours supérieurs n'avait été bouleversé, je dis à ASKLÉPIOS mon disciple de m'apporter le « Livre des sphères, celui de l'astronomie ». Cf. p. 345. Ce « Livre des sphères » est nommé encore dans un traité astronomique et météorologique attribué à DENYS L'ARÉOPAGITE et conservé dans un ms. syriaque du VII[e] siècle. Ce texte a été publié aussi par KUGENER dans les *Actes du XIV[e] Congrès des Orientalistes*, Paris, 1907, p. 137. La citation se trouve p. 158, l. 15, trad. p. 185, l. 18 : « le livre des sphères de l'astronomie ». — Cf. PEETERS, *l. c.*, p. 320, note 1.

(5) Ps. DENYS, Lettre 7 à POLYCARPE (P. G. III, p. 1081).

des œuvres qui sont attribuées à DENYS L'ARÉOPAGITE, mais qui, en réalité, on le sait, ont été composées en Syrie vers l'an 500. Il ressort des termes même de cette épître que c'était un récit déjà bien connu à cette époque. Cette légende chrétienne, comme beaucoup d'autres, paraît donc avoir été imaginée en Syrie au Ve siècle. A cette date l'astronomie grecque était encore cultivée et l'hagiographe qui le premier a décrit le prodige céleste dont on aurait eu le spectacle à Héliopolis, a pu trouver dans quelque manuel didactique l'indication d'une vieille *regula Philippi*, qu'il a introduite dans sa narration. L'action de ce roman étant censée se passer au moment de la mort de JÉSUS, il fallait, pour sauvegarder la vraisemblance, citer un ouvrage d'astronomie antérieur à PTOLÉMÉE.

A ma connaissance, le seul érudit moderne qui se soit demandé ce que pouvait être cette *regula* est BÖCKH dans ses « Cycles solaires » (6) parus en 1863. Adoptant une conjecture exprimée incidemment dans une note par FABRICIUS (7), BÖCKH croit à une erreur de lecture de l'auteur de la lettre à APOLLOPHANE qui aurait écrit PHILIPPE ARRHIDÉE au lieu de PHILIPPE DE MEDMA, le disciple de PLATON — *Aridaeus* pour *Medmaeus* — et la « règle » invoquée serait simplement celle que les éclipses de soleil ne peuvent se produire que quand cet astre est en conjonction avec la lune, ou, en langage vulgaire, à la nouvelle lune. Mais si DENYS, dans l'histoire qu'on nous rapporte, avait simplement voulu invoquer un principe connu de tous dans l'antiquité comme de nos jours, quel besoin avait-il de recourir à un ouvrage d'astronomie, celui d'ARRHIDÉE dans la lettre à APOLLOPHANE, devenu le « Livre des sphères » dans l'autobiographie syriaque ?

Puisque nous avons affaire à une traduction du grec, on doit se demander quel mot répondait dans le texte original au *regula* latin. Certainement *κάνων*. Mais *κάνων* qui, dans le langage ordinaire, signifie « règle » « mesure » a chez les astronomes et les chronographes le sens technique de « table » : une table indiquant dans ses colonnes, soit les chiffres de la position des étoiles, soit ceux de dates historiques. En d'autres termes, l'ouvrage en

(6) BÖCKH, *Ueber die vierjährigen Sonnenkreise der Alten, vorzüglich den Eudoxischen*, Berlin, 1863, p. 38.

(7) FABRICIUS-HARLESS, *Bibliotheca Graeca*, VII, p. 13.

question est un canon des éclipses. Déjà les Babyloniens, à la suite de leurs longues observations, avaient noté que les occultations du soleil se reproduisaient assez exactement suivant un cycle de 54 ans et 31 jours. Ils avaient, en se fondant sur l'expérience plus que sur le calcul, dressé des tables de la récurrence des éclipses, et elles leur permettaient de prédire celles-ci avec une probabilité assez grande (8). C'est un canon de cette espèce que l'Aréopagite est censé, très naturellement, avoir consulté pour savoir si l'éclipse d'Héliopolis était astronomiquement possible le jour où elle avait eu lieu.

FABRICIUS et BÖCKH à sa suite, nous le disions, ont cru que PHILIPPE ARRHIDÉE avait dans la lettre à APOLLOPHANE usurpé la place de PHILIPPE DE MEDMA, dit aussi d'OPUS, l'élève de PLATON, qui édita les *Lois* et composa peut-être l'*Epinomis* (9). Cette hypothèse n'est pas dénuée de quelque probabilité. Car nous savons que ce philosophe platonicien, qui s'adonna à l'étude des phénomènes célestes, avait écrit un livre *Sur les éclipses de Lune* et SUIDAS nomme, en outre, dans la copieuse énumération de ses œuvres, des traités *Sur la grandeur du soleil, de la lune et de la terre*, *Sur la distance du soleil et de la lune* (10). Mais précisément l'observation des éclipses fut pour les anciens la méthode principalement employée pour mesurer la grandeur et la distance des astres.

Il paraît donc assez vraisemblable que PHILIPPE D'OPUS aît dressé un canon des éclipses de soleil d'après le calendrier grec, qu'il avait lui-même contribué à rendre plus exact (11), comme avant lui les Chaldéens l'avaient fait selon leur mode de computation.

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(8) Cf. FRANZ BOLL dans son excellent article « Finsternisse » de la *Realenc.* VI, col. 2339. BOLL n'a cependant pas connu la lettre à APOLLOPHANE.

(9) Sur PHILIPPE DE MEDMA, appelé aussi PHILIPPE D'OPUS, cf. en dehors de BÖCKH, ZELLER, *Philos. Griechen*, III⁴, p. 991, note 1.

(10) SUIDAS, s. v. *Φιλόσοφος : σχολάσας τοῖς μετεώροις, ὧν δὲ κατὰ Φίλιππον τὸν Μακέδονα συνεγράψατο τάδε· Περὶ τῆς ἀποστάσεως ἡλίου καὶ σελήνης·.. Περὶ ἐκλείψεως σελήνης. Περὶ μεγέθους ἡλίου καὶ σελήνης καὶ γῆς.* Cf. STOBÉE, I, p. 221, 6, Wachsm. — Cf. BOLL, *l. c.* col. 2346. TANNERY, *Mémoires scientifiques*, t. I, p. 372.

(11) GEMINOS, *Isag.* VIII, 50 : *Ἐπειδὴ διημαρτημένην εἶναι συνέβαινε τὴν ὀκταετηρίδα κατὰ πάντα, ἑτέραν περίοδον συνεστήσαντο τὴν τῆς ἐννεακαιδεκαετηρίδος οἱ περι Εὐκτήμονα καὶ Φίλιππον καὶ Κάλλιππον ἀστρολόγοι.*

Cependant je garde des doutes et l'autorité combinée de FABRICIUS et de BÖCKH ne suffit pas à emporter ma conviction. Car, au point de vue paléographique, la confusion de *ΑΡΡΙΔΑΙΟΣ* ou *ΑΡΙΔΑΙΟΣ* et de *ΜΕΔΜΑΙΟΣ* n'est pas aisée et, de plus, on ne voit pas pourquoi le nom du successeur éphémère d'ALEXANDRE LE GRAND se serait présenté spontanément à l'esprit d'un copiste chrétien. Une correction consciente est encore moins vraisemblable, car pourquoi aurait-on prêté gratuitement à un prince Macédonien, qui par surcroît passait pour faible d'esprit, la rédaction de tables astronomiques? J'inclinerais donc à croire plutôt qu'il s'agit d'une œuvre que ce prince aurait patronnée, ou qui lui aurait été présentée et dédiée par quelque astronome, soit PHILIPPE D'OPUS, s'il a vécu jusque sous son règne (12), soit CALLIPPE, l'auteur du cycle lune-solaire qui porte son nom (13), soit un autre. Ce canon aurait pris le nom du roi de Macédoine à peu près comme les tables Alphonsines ont dû le leur à ALPHONSE LE SAGE de Castille.

Qu'elle doive son titre au roi PHILIPPE ou à l'astronome PHILIPPE, l'œuvre dont un hagiographe de l'époque carolingienne nous révèle seul l'existence, remonterait à la seconde moitié du IV^e^ siècle avant notre ère. Elle prendrait place parmi les écrits de ces premiers platoniciens qui enseignèrent à la Grèce la science des astronomes « chaldéens ». Ce canon serait une première tentative pour déterminer, suivant le calendrier luni-solaire des Grecs, le retour des éclipses, avant qu'HIPPARQUE, par une connaissance plus exacte des parallaxes, arrivât à prédire par le calcul le moment précis où ce phénomène devait se produire en un lieu déterminé de la terre.

(Rome.) FRANZ CUMONT.

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(12) La date de la mort de PHILIPPE D'OPUS n'est pas connue. On sait seulement qu'il survécut à PLATON († 347). Il n'est pas exclu qu'il ait vécu jusqu'au règne de PHILIPPE ARRHIDÉE, tué en 317. Peut-être même le *Φίλιππος ὁ Μακέδων* nommé par SUIDAS (*supra* note 10) n'est-il pas le père d'ALEXANDRE (360-336) mais son frère consanguin et successeur sur le trône de Macédoine, ARRHIDÉE.

(13) Cf. *Realenc.* s. v. « Kallippische Periode ».

Tractatus de Continuo von Thomas Bradwardina

EINE HANDSCHRIFT AUS DEM XIV. JAHRHUNDERT

Vor einigen Jahren stiess ich in der Stadtbibliothek in Torun (Thorn) auf eine noch nicht publizierte Handschrift TH. BRADWARDINAS (ca. 1290-1349), über Stetigkeit. Diese Handschrift, welche die Signatur R. 4° 2 trägt, beschrieb vor einigen Jahrzehnten M. CURTZE (1), und gab zugleich einige, ziemlich regellose, und nicht immer richtig entzifferte Auszüge aus ihr. Diese Auszüge benutzten später in ihren sehr flüchtigen Charakteristiken des Standpunktes BRADWARDINAS in Sachen der Stetigkeit K. LASSWITZ (2), wenn es sich um Atomistik, und M. CANTOR (3), wenn es sich um Mathematik handelt. Nachdem ich den Inhalt der Handschrift genau untersucht hatte, bin ich zur Überzeugung gekommen, dass er einen recht grossen Wert nicht nur deshalb besitzt, weil BRADWARDINA der grösste englische Mathematiker des XIV. J. genannt werden muss, sondern auch deshalb, weil sein " Tractatus de Continuo " mit mathematischen und naturwissenschaftlichen Ideen des Mittelalters eng verbunden erscheint, Ideen, welche auf die spätere Entwickelung der Mathematik mächtig eingewirkt hatten, und was noch für uns sich interessanter zeigt, Ideen, welche mit heutigen Untersuchungen über das Wesen der Unendlichkeit und Stetigkeit, innig zusammenhängen. Ich beschloss deshalb den ganzen Text des Traktats zu veröffentlichen,

(1) Analyse d. Handschrift R. 4° 2, *Zs. f. Math. u. Phys.*, XIII, oder im Separatabdruck, 1868. Dort auch eine kurze Biographie BRADWARDINAS. In dieser Hinsicht vgl. auch M. CANTOR, *Vorl. ü. Gesch. d. Math.*, II, und ÜBERWEGS, *Gesch. d. Philos.*, II.

(2) *Gesch. d. Atomistik*, I, 1890, p. 197 f.

(3) *Vorl. ü. Gesch. d. Math.*, II.

und sah sich nach anderen Exemplaren um. Die diesbezüglichen Nachforschungen in einigen grösseren Bibliotheken hatten nicht viel gebracht; nur in Erfurt fand sich noch ein Exemplar des " Tractatus," ohne Namen des Verfassers und ohne Schluss, und zwar in der Stadtbibliothek zu Erfurt (4). Auf Grund dieser beiden Handschriften stellte ich den kritischen Text zusammen, welcher in nächster Zeit wird veröffentlicht werden.

Die Thorner Handschrift, welche ausser dem Traktat BRADWARDINAS noch andere Werke umfasst, unter diesen auch BRADWARDINAS " Geometria speculativa," ist jenes Exemplar, aus welchem M CURTZE das berühmte Werk " Algorithmus proportionum " v. N. ORESME (1323-1382) veröffentlicht hatte, welches ganz neues Licht auf mittelalterliche Mathematik wirft. Die ganze Handschrift ist wahrscheinlich um das Jahr 1359 abgeschrieben worden, besitzt das Format 20 × 14,5 cm. und ist auf dickem Papier mit stark gekürzter, an manchen Stellen fast unlesbarer Brachygraphie geschrieben. Die Seiten besitzen fast immer 42 Zeilen. Der Traktat befindet sich auf den Seiten 153 bis 192, darin 187, 187^1, 187^2, also zusammen auf 41 Seiten. Die Erfurter Handschrift stammt wahrscheinlich aus der zweiten Hälfte des XIV J., ist zwar deutlicher geschrieben, aber durch fast unzählige Abschreibefehler und Auslassungen entstellt. Ausserdem fehlen die Seiten 154 Zeile 4 bis 155 Z. 31, und die Seiten 187^1, Z. 28 bis 192, Z. 15 der Thorner Handschrift, also 7 Seiten, darunter der ganze Schluss (6 Seiten). Der Traktat umfasst in der Erfurter Handschrift die Seiten 17 r. bis 48 v. Von Seite 54 r bis 55 v befindet sich eine Zusammenfassung des 5. Kapitels BRADWARDINAS Schrift über Proportionen der Geschwindigkeiten, und auf Seite 55 v., von Zeile 19, ist wieder der Anfang des „Tractatus de Continuo" abgeschrieben (bis Seite 154, Z. 2 der Thorner Handschrift).

Zur Herstellung des kritischen Textes habe ich als Grundlage die Thorner Handschrift gewählt, als ohne Zweifel korrekter und voller. Die Erfurter Handschrift ist einige Jahre später als die Thorner entstanden, und scheint von einem schlechten Abschreiber verfertigt worden zu sein. Es muss aber bemerkt werden, dass auch das Thorner Exemplar grössere Auslassungen aufweist.

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(4) Stadtbücherei Erfurt, Handschr. Nr. C A 4° 385, p. 17 r.-48 r.

Anfangs war ich nicht gänzlich sicher, ob der „Tractatus de Continuo" wirklich von BRADWARDINA stammt. CURTZE zweifelt darüber gar nicht, indem er sich wahrscheinlich auf die Endworte der Thorner Handschrift stützt : " Explicit tractatus Bratwardini de continuo." Auch LASSWITZ und M. CANTOR sind derselben Meinung. Aber es ist bemerkenswert, dass das Werk eines so bekannten Gelehrten wie BRADWARDINA nicht nur nicht veröffentlicht wurde, sondern auch gänzlich in Vergessenheit fiel. Schon SAVILE, in der Ausgabe „De causa Dei contra Pelagium", einer theologischen Schrift BRADWARDINAS, welche im J. 1618 in Paris erschien, und in deren Einleitung SAVILE die Schriften BRADWARDINAS aufzählt, erwähnt unseren Traktat gar nicht. Auch später, insofern es mir bekannt ist, findet sich bis CURTZE keine Erwähnung darüber. Das Erfurter Exemplar bestätigt die Autorschaft BRADWARDINAS, welche am S hluss des Thorner Exemplars ausdrücklich bezeichnet wird, nicht, da der Schluss fehlt, und am Anfang der Verfasser nicht erwähnt ist. Man darf darüber jedoch nicht im Zweifel sein, da der Verfasser des „Tractatus de Continuo" sich im Text auf das Werk „De proportione uelocitatem in motibus" beruft (5), welche, wie bekannt, von BRADWARDINA stammt (6).

Der „Tractatus de Continuo" hat die Aufgabe die S t r u k t u r der S t e t i g k e i ι zu ergründen. Es ist möglich, dass BRADWARDINA noch eine Fortsetzung zu verfassen beabsichtigte, oder sogar verfasst hatte, welche wir nicht kennen. Dies könnte man aus den Schlussworten des Traktats folgern : „Sic igitur primus liber, qui est de compositione continui, quantum ad sua essentialia, finem capit. Amen. Explicit tractatus Bratwardini de continuo" (7). Jedenfalls bildet unsere Handschrift ein Ganzes für sich und zwar ein umfangreiches Ganzes; die Thorner Handschrift des Traktats umfasst zwar nur 41 Seiten, aber wegen sehr kompakter Brachygraphie, gibt das ca. 5 Druckbogen in 8°.

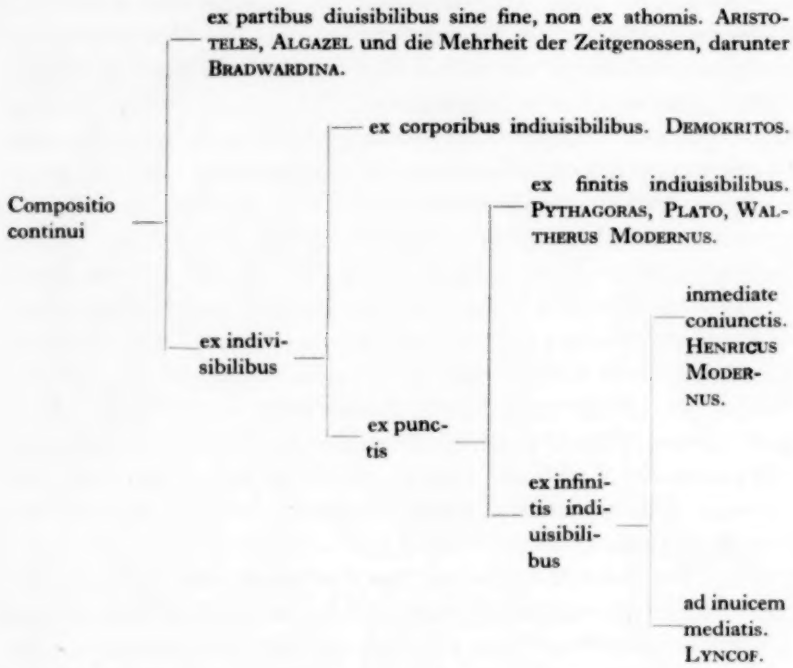
Der ganze Traktat ist kritisch gehalten. BRADWARDINA polemisiert stets mit Anschauungen früherer Gelehrter und mit seinen Zeitgenossen. Die Anschauungen über die Struktur des Konti-

(5) S. 164, Z. 15 der Thorner Handschr.; Erf. Handschr. 24 v., Z. 25, und öfters.

(6) Es erschien in Venedig im J. 1505 und befindet sich auch in unserer Erfurter Handschrift. Vgl. P. DUHEM, *Études sur Léon. da Vinci*, 1906.

(7) T (so bezeichnen wir die Thorner Handschr.), p. 192, Z. 25, und öfters.

nuums stellt er an einer Stelle zusammen (8), welche in T, am Rande, mit der Notiz: „Nota quinque opiniones de compositione continui" bezeichnet ist. Schematisch lassen sich diese Anschauungen folgendermassen darstellen:


Compositio continui
ex partibus diuisibilibus sine fine, non ex athomis. Aristoteles, Algazel und die Mehrheit der Zeitgenossen, darunter Bradwardina.
ex indivisibilibus
ex corporibus indiuisibilibus. Demokritos.
ex punctis
ex finitis indiuisibilibus. Pythagoras, Plato, Waltherus Modernus.
ex infinitis indiuisibilibus
inmediate coniunctis. Henricus Modernus.
ad inuicem mediatis. Lyncof.

Bradwardina erwähnt also von den Zeitgenossen den Walterus, Henricus und Lyncof, und mit diesen polemisiert er am häufigsten. Waltherus Modernus ist wahrscheinlich Walter Burleigh, der Verfasser des Werkes über „Latitudo formarum", welcher im J. 1337 gestorben ist (9); Curtze (10) ist der Meinung, was mir zweifelhaft erscheint, dass es sich um den Walter Evesham handelt, welcher um das Jahr 1316 astronomische Beobachtungen anstellte. Henricus Modernus ist Henricus Goethaels (Henricus Gandavensis, 1217-1295), doctor solemnis, Professor der Philosophie in Paris, der Verfasser eines Kommentars zur Physik

(8) T, p. 165, Z. 29-39; E (so bezeichnen wir die Erfurter Handschr.), p. 25 v., Z. 28 bis 26 r., Z. 8.

(9) Vgl. Prantl, *Gesch. d. Logik*, III, 297. Cantor, *Gesch. d. Math.*, II.

(10) L. c., p. 44 der Sonderausgabe.

und Metaphysik des ARISTOTELES (11). LYNCOF ist möglicherweise ROBERT GROSTHEAD, Bischof zu Lincoln, welcher in Oxford und Paris studierte, und sich mit Philosophie, Theologie, Astronomie und Linguistik befasste. Er starb im J. 1253. Er ist Verfasser des „Compendium sphaere mundi" und „Commentarius in libros posteriores Aristotelis".

Seinen Standpunkt gegenüber dem Problem des Kontinuums fasst BRADWARDINA gegen Schluss seines Werkes im Satze 140 (12) zusammen: „Ut igitur alchymista post multos ignes aurea gaudet massa, uictor quoque, terminatis laboribus pluribus, gaudet de triumpho, sic et tu, post tot scrutinia studiorum, carissimis amplecte affectibus sinceram, que sequitur ueritatem: N u l l u m c o n t i n u u m e x a t h o m i s i n t e g r a r i, unde sequitur et elicitur: Omne continuum ex infinitis continuis similis speciei cum illo componi... id est linea omnis componitur ex infinitis lineis et omnis superficies ex superficiebus infinitis et ita de aliis."

Die moderne Mathematik und Naturwissenschaft fasst anders das mathematische, anders das physikalische Kontinuum auf. Der EINSTEIN-MINKOWSKISCHE Zeit-Raum bildet ein Kontinuum, welches noch auf verschiedene Weise interpretiert wird. Die klassische Theorie G. CANTORS betrachtet das mathematische Kontinuum als g e g e b e n, als eine Art Platonischer Ideen; ein solches Kontinuum braucht keine Konstruktion, sondern nur Beschreibung. Verwandt ist die axiomatische Auffassung HILBERTS. Es existieren aber auch solche Theorien des mathematischen Kontinuums, welche Konstruktionen erfordern, und diese sind denjenigen des Altertums und Mittelalters verwandt, selbstverständlich auf höherem Niveau. H. WEYL (13) verzichtet auf das Eindringen in das Wesen des Kontinuums, und begnügt sich mit der Konstruktion einer Art atomistischen Models, als überall dichter Punktmenge. Dies entspricht dem Standpunkte, welchen BRADWARDINA gegenüber HENRICUS GOETHAELS und LYNCOF bekämpft. Die neointuitionistische Schule (BROUWER (14))

(11) Vgl. CANTOR, *l. c.*

(12) T, p. 187^2, Z. 27 ff., 37 ff.; E fehlt.

(13) D. Continuum, 1918.

(14) Z. Begründung d. intuitionistischen Mathematik, *Math. Annalen*, Bd. 93 f. u. spätere Arbeiten im *Jahresbericht d. deutschen Math. Ver.*, Bd. 33 und *Crelles Journal*, Bd. 154.

fasst dagegen das Kontinuum als aus Teilen bestehend auf, welche ihrerseits wieder Kontinua darstellen, welche also in infinitum teilbar sind. Der einzelne bestimmte Punkt erscheint auf diesem Standpunkte als eine Folge in sich eingeschlossener Intervalle. Wir sehen, dass die Theorie BROUWERS, dem Wesen nach, der Theorie BRADWARDINAS, welche im oben angegebenen Satze zusammengefasst ist, ähnlich erscheint.

Ähnliche Anschauungen finden wir früher auch bei M. W. DROBISCH, dem Bekenner des Herbartschen Realismus (15). Nach DROBISCH ist im Diskreten das Ganze durch Teile bedingt, welche wirkliche Bestandteile dieses Ganzen sind, im Kontinuum dagegen umgekehrt Teile durch das Ganze. In diesem letzten Falle besteht das Ganze aus Teilen nicht, sondern ist nur teilbar, d.h. kann als etwas aufgefasst werden, was Teile haben k a n n . „Denn da jeder Teil einer stetigen Grösse wieder eine solche sein muss, weil sonst das Ganze aus einer Vielheit diskreter Grössen bestehen und daher selbst eine diskrete Grösse sein würde, so folgt, da nur auch wieder diese Teile des Ganzen, als stetige, teilbar sein müssen, dass die Teilung hier nie ein Ende erreichen kann, dass die stetige Grösse als unendlichteilbar gedacht werden muss, und dass man bei dieser ohne Ende fortgesetzter Teilung niemals auf kleinste, sondern nur auf beliebig kleine, d.h. solche kommt, die kleiner sind, als jede auch noch so kleine gegebene Grösse, und deren Anzahl daher grösser sein muss, als jede auch noch so grosse gegebene Zahl..." „Nicht als Seiendes, sondern als Werdendes soll nun das Unendlichkleine gedacht werden".

Handelt es sich um physikalische Stetigkeit, so sind die Anschauungen des ARISTOTELES, also im Grunde auch BRADWARDINAS, seit einigen Jahrhunderten als nicht annehmbar erklärt worden, und die atomistische Theorie der Materie ist in letzter Zeit auch auf Energie angewendet (Quantentheorie). ARISTOTELES unterschied mathematische und physikalische Stetigkeit nicht, denn er negierte die Existenz eines leeren Raumes. Deshalb übertrug er die Stetigkeit des Raumes auch auf die Materie. Auf entgegengesetztem Standpunkte stand im Mittelalter, seit IX. bis zum XIII. J. die arabische Schule der MOTAKHALLEMIN, welche

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(15) Synechologische Untersuchungen, *Zs. f. Philos. u. philos. Kritik*, 1854, Neue Folge, Bd. 25, p. 179-208, besonders 189-193.

nicht nur Raumatome, sondern auch Zeit und Bewegungsatome zuliess (16). BRADWARDINA als Anhänger des ARISTOTELES bekämpft jede Atomistik.

Die Disposition des Traktats ist folgende. Am Anfang gibt BRADWARDINA 24 Definitionen gewisser allgemeiner Begriffe (17), dann 10 Postulate (18) (suppositiones) und endlich 150 Sätze (19) (conclusiones), in denen er die Anschauungen seiner Gegner bekämpft und seine begründet.

Das Kontinuum definiert BRADWARDINA (20) als „quantum, cuius partes ad inuicem copulantur". Das ist der erste Satz des Traktats. Diese Definition ist allgemeiner, als diejenige von ARISTOTELES (21), nach welcher das Zusammenhängende *(ἐχόμενον)* stetig ist *(συνεχές)*, wenn die tangierenden Grenzen der zusammenhängenden Teile identisch sind; zusammenhängend ist aber das, was aufeinander folgt *(ἐφεξῆς)* und sich berührt. BRADWARDINA teilt das Kontinuum in „permanens" und „successiuum". Als Beispiel eines „continuum permanens" dient ein Körper (corpus), eine Fläche und eine Linie (22), als Beispiel eines „continuum successiuum" die Zeit (23) und die Bewegung (24).

Ausführlicher bespricht BRADWARDINA zwei Arten des U n e n d l i c h e n, welche er unterscheidet, das „infinitum cathetice" und „syncathetice" (25). „Infinitum cathetice... est quantum sine fine, ' oder auch „magnum uel multum sine fine, seu non finitum" (26). Es ist dies also das Unendliche, welches heute a k t u a l genannt wird, und deren mathematische Theorie G. CANTOR in seiner Mengenlehre gegeben hat. „Infinitum syncathetice.. est quantum finitum et finitum maius isto, et finitum maius isto maiori, et sic sine fine ultimo terminante,

(16) Vgl. LASSWITZ, *l.c.*, vor allem p. 146 f. und L. MABILLEAU, *Hist. de la philos. atomistique*, 1895, p. 319 f.
(17) T, p. 153-156; E, 17 r.-18 r.
(18) T, p. 156; E, 18 r.
(19) T, p. 156 bis Ende; E, 18 r. bis Ende.
(20) T, p. 153, Z. 12; E, 17 r., Z. 1.
(21) Phys. V, 3, 226 *b*, 227 *a*.
(22) T, p. 153, Z. 14-16; E, 17 r., Z. 3.
(23) T, p. 153, Z. 18; E, 17 r., Z. 6.
(24) T, p. 153, Z. 19; E, 17 r., Z. 7.
(25) T, p. 153, Z. 30-33; E, 17 r., Z. 20-23.
(26) T, p. 154, Z. 3; E, 17 v., Z. 5.

et hoc est quantum et non tantum quin maius" (27), oder auch „magnum uel multum sine fine et hoc quantolibet finito maius uel plura" (28). Es ist dies also das potentielle Unendliche, welche auf der Möglichkeit der Bildung einer unbeschränkten Reihe von wachsenden resp. abnehmenden Grössen beruht. Sowohl das kathetische als auch das synkathetische Unendliche gelten für stetige und diskrete Grössen (29). Das synkathetische Unendliche entsteht nach BRADWARDINA auf zweifache Weise, „uno modo per priuationem finis intrinseci, alio modo per priuationem intrinseci et extrinseci" (30). Innere Grenze ist aber eine solche Grenze einer Menge, welche selbst zur Menge gehört, während äussere Grenze zur gegebenen Menge nicht gehört. Es ist also für BRADWARDINA die Zahl 2 eine innere Grenze der natürlichen Zahlenreihe, während 1 eine äussere Grenze bildet (31); in dieser Zeit war nämlich 1 fast allgemein noch nicht für eine Zahl im strengen Sinne betrachtet. Interessant ist BRADWARDINAS Bemerkung, dass der Punkt eine äussere Grenze einer stetigen Menge ist (32). Die Menge der stetigen Grösse ist hier die Menge der Intervalle (Abschnitte), die ineinander eingeschachtelt sind. Vom Standpunkte BRADWARDINAS ist diese Auffassung des Punktes natürlich, denn im entgegengesetzten Falle, wenn der Punkt eine innere Grenze wäre, würde sich das Kontinuum in Punkte, also Atome, zerlegen lassen. Eine ganz ähnliche Auffassung de Punktes finden wir heute bei BROUWER. Auch G. CANTORS Thoerie der Irrationalzahlen steht auf demselben Standpunkte. Mit Hilfe des kathetischen Unendlichen lassen sich alle Erscheinungen nicht auffassen; das synkathetische Unendliche ist deshalb unumgänglich (33). Vom Standpunkte der Stetigkeit ist das synkathetische Unendliche sogar wichtiger. Die Methoden der höheren Analysis, welche im XVII. J. auftauchten, hängen eng mit diesem Begriffe zusammen. Zwar schon ARCHIMEDES operierte mit der Richtungsänderung als Grösse, indem er Kurven-

(27) T, p. 153, Z. 31; E, 17 r., Z. 21.
(28) T, p. 154, Z. 4; E, fehlt.
(29) T, p. 154, Z. 6; E, fehlt.
(30) T, p. 155, Z. 24; E, fehlt.
(31) T, p. 154, Z. 13; E, fehlt.
(32) T, p. 154, E. 14; E, fehlt.
(33) T, p. 154, Z. 28; E, fehlt.

längen und Flächengrössen berechnete, aber die höhere Analysis erfordert, dass man mit beliebiger quantitativen Veränderung rechnet, und diese Rechnung wurde erst im XVII. J. erfunden. Dabei kam das synkathetische Unendliche zur vollen Geltung. BRADWARDINA definiert dasselbe zu eng, indem er nur das Wachsen der Grössen in der Definition berücksichtigt. Jedenfalls aber ist dieses Wachsen für ihn eine Grösse (34). Wir finden aber auch Stellen, an welchen BRADWARDINA von unbegrenzt abnehmenden Grössen spricht, welche im XVII. J. zum Begriff des Differentials geführt hatten (35). Auch die Hauptthese BRADWARDINAS, dass das Kontinuum aus „infinitis continuis similis speciei" besteht, ist ohne den Begriff des unbeschränkt Abnehmenden unverständlich. Endlich kennt BRADWARDINA die Begriffe „latitudo formarum" und „remissio formarum" (36), und dieser letztere Begriff bei unbegrenzter Abnahme ist mit dem besprochenen identisch. Den Begriff des Differentials hat jedoch BRADWARDINA nicht bilden können, denn er rechnet mit dem unbeschränkt Abnehmenden nicht; dazu war noch die Zeit nicht gekommen, denn diese Rechnung stützt sich nicht nur auf Denken, sondern auch auf Naturbetrachtung, welche im Mittelalter eher vermieden wurde.

Nach den Definitionen folgen 10 „suppositiones", „que per se patent omnibus" (37) und welche in weiterem Gedankengange benutzt werden. Es sind dies allgemeine Postulate, wie z.B. „omne maius posse diuidi in equale et in differentiam, qua excedit", „si finitum addatur finito, totum erit finitum," „omnia mediata distare, omnia diuisa mediari" u.s.w. „Suppositiones" 6 bis 9 beziehen sich auf gleichmässige Bewegung.

In den 150 „conclusiones", welche den eigentlichen Teil des Traktats ausmachen, entwickelt BRADWARDINA seine Anschauungen über das Kontinuum, und vor allem bekämpft er die Anschauungen seiner Gegener. Dabei berücksichtigt er alle möglichen Gebiete der Wissenschaften, Arithmetik, Geometrie, Physik, Musik und humanistische Wissenschaften. Wir wollen zuerst den kritischen

(34) T, p. 153, Z. 33; E, 17 r., Z. 23.
(35) T, p. 154, Z. 11; E, fehlt.
(36) T, p. 166, Z. 3; E, 26 r., Z. 19. T, p. 170, Z. 26; E, 30 v., Z. 10. T, p. 173, Z. 1; E, 32 v., Z. 21. T, p. 185, Z. 7; E, 44 v., Z. 17.
(37) T, p. 156, Z. 20-35; E, 18 r., Z. 11 bis 18 v., Z. 1.

Teil besprechen. Falls unteilbare Elemente (indiuisibilia), d.h. Atome im allgemeinsten Sinne existierten, so müssten sie einander gleich sein (38). Einerseits kann nämlich ein indiuisibile nach der Definition (Def. 1) nicht teilbar sein (38), und andererseits nach dem 1 Postulat „omne maius posse diuidi in equale et in differentiam, qua excedit" (38). Zwei Kontinua derselben Art, welche aus gleicher Anzahl von Atomen beständen, müssten einander gleich sein (39). An demselben Orte können nicht mehrere Atome sich befinden (Undurchdringlichkeit) (40). Ebenso wie vom Ende eines Abschnittes mehrere seiner Punkte nicht gleichentfernt sein können, so können auch mehrere Atome eines Kontinuums nicht gleichentfernt sein von irgendeiner seiner Schranken auf derselben Seite (41). Es folgt daraus, dass an derselben Seite eines Atoms im Kontinuum mehrere Atome unmittelbar nicht liegen können (42).

Im 17. Satze wird das Problem des Kontingenzwinkels (angulus contingentie), d.h. des Winkels zwischen Kreisbogen und Tangente, des Bogenwinkels (angulus peripherie) zwischen zwei Bögen tangierender Kreise, und des Kontingenzdreiecks (triangulus contingentie), d.h. des Dreiecks, welcher durch Kreisbogen, Tangente und Gerade gegenüber dem Kontingenzwinkel gebildet ist, berührt (43). In dieser Zeit war dieses Problem durch die Mathematiker lebhaft diskutiert, denn der Kontingenzwinkel besitzt gewisse Eigenschaften, welche von denjenigen des ebenen Winkels grundverschieden sind. Schon Euklides spricht davon (44), dass der Kontingenzwinkel kleiner ist als ein beliebiger ebener akuter Winkel. Später untersuchen den Kontingenzwinkel Jordanus Nemorarius (45) (XIII. J.) und Johannes Campanus (46) (XIII. J.). Nach Bradwardina nahmen dieses Thema, welches mit dem Begriff des Unendlichkleinen verwandt ist, erst Cardano, Peletier, Vieta auf. In dem erwähnten 17. Satze

(38) T, p. 156, Z. 37, conclusio 1; E, 18 v., Z. 2.
(39) T, p. 156, Z. 38, concl. 2; E, 18 v., Z. 3.
(40) T, p. 157, Z. 1, c. 3; E, 18 v., Z. 6.
(41) T, p. 157, Z. 7-24, c. 4; E, 18 v., Z. 13 bis 19 r., Z. 4.
(42) T, p. 157, Z. 25, c. 5; E, 19 r., Z. 4.
(43) T, p. 161, Z. 13 ,c. 17; E, 22 r., Z. 8.
(44) III, 16.
(45) *De triangulis*, III, 12.
(46) In der Ausgabe des Euklid.

handelt es sich um Teilung des Kontingenzwinkels, des Bogenwinkels und des Kontingenzdreiecks, welche durch Geraden vom Scheitel des Kontingenzwinkels nicht geteilt werden können, durch Kreisbögen. Beim Beweise erwähnt BRADWARDINA „De sphaeris" von THEODOSIUS (47).

Gelegentlich einer geometrischen Diskussion erklärt BRADWARDINA die kugelige Gestalt der Wasseroberfläche auf der Erde und in den Gefässen (48).

In vielen Sätzen (49) bedient sich BRADWARDINA des Begriffs der " latitudo formarum". Diese Methode ist heute vom geschichtlichen Standpunkte aus, vielleicht unterschätzt und deshalb noch nicht völlig klar. Es existieren aber ziemlich viele Handschriften in einigen Bibliotheken Europas, die noch nicht verwertet worden sind. DUNS SCOTUS hat um 1300 das Problem der Form in dem zu besprechenden Sinne ans Licht gebracht. Die Form in dieser Bedeutung ist ein veränderlicher Gegenstand; weil aber die Änderung am besten bei Grössen beobachtbar ist, so ist es nicht verwunderlich, dass die Begriffe „intensio" und „remissio" entstanden sind. In diesem Sinne spricht von den Formen auch BRADWARDINA. In diesem Sinne wurde das Problem auch von WALTHERUS MODERNUS u.a. behandelt. Weil aber die Formen Grössen sind, sollen sie mathematisch aufgefasst werden. In dieser Richtung arbeiten R. SUISSET im XIV. J. und N. ORESME (1323-1382). SUISSET untersucht die „latitudines formarum" im 1. und 2. Abschnitte seines „Calculators", welcher erst im J. 1520 im Drucke erschienen ist, und welcher schon einige Jahre nachher zu einer Seltenheit wurde (50). Wir finden dort die oben erwähnten Begriffe und ausserdem den Begriff „difformis". SUISSET veranschaulicht seine Darstellung mit geometrischen Figuren, welche mit denen von DESCARTES verglichen werden können (51).

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(47) THEODOSIUS ist in E zitiert; in T steht an derselben Stelle THEMISTIUS, wahrscheinlich der Kommentator des ARISTOTELES. CUTRZE (*l.c.*, p. 43) interpretiert den Namen " THEMISTIUS " irrtümlich als " THEMISTOCLES " (cf. HEILBRONNER, *Hist. Math. Univ.*, p. 572).

(48) T, p. 161, Z. 28, p. 162, Z. 43, c. 19; E, 22 r., Z. 30, 23 v., Z. 10.

(49) T, p. 166, Z. 3, p. 170, Z. 26, p. 173, Z. 1, p. 185, Z. 7; E, 26 r., Z. 19, 30 v., Z. 10, 32 v., Z. 21, 44 v., Z. 17.

(50) Vgl. KÄSTNER, *Gesch. d. Math.*, 1796, I, p. 50 f.

(51) Vgl. CANTOR, *Gesch. d. Math.*, II.

ORESME hat das Problem weiter gefördert (52). Dieser Mathematiker, der grösste des XIV. J., verfasste einen „Tractatus de latitudinibus formarum", ungefähr im J. 1360; dieses Werk wurde später mehrmals herausgegeben (53), und befindet sich, wie schon erwähnt, in T. Der Grundgedanke der „latitudo formarum" ist derjenige der analytischen Geometrie von DESCARTES, wobei auch der Begriff der Funktion ans Licht kommt. Es fehlt jedoch an algebraischer Seite; Gleichungen werden noch nicht benutzt. ORESME sagt ausdrücklich : „Quia formarum latitudines multipliciter uariantur et multiplicitas difficillime discernitur nisi ad figuras geometricas consideratio referatur" (54). ORESME fügt auch dem Text zahlreiche Figuren bei. „Latitudo" ist die Ordinate der analytischen Geometrie, „longitudo" die Abszisse. Die Differenz Dy nacheinanderfolgender „latitudines" heisst „gradus latitudinis". Ist dieser „gradus" gleich Null, so haben wir „latitudo uniformis" vor sich, im entgegengesetzten Falle „latitudo difformis". Diese letzte „latitudo" hat wieder verschiedene Kategorien, welchen vom geometrischen Standpunkte aus, verschiedene gerade und krumme Linien entsprechen. Das Mass der Veränderlichkeit ist „excessus graduum" Bilden die „latitudines" eine arithmetische Reihe 2-er Ordnung, so ist der „excessus" konstant. Auch der Satz, dass in der Umgebung des Maximums „gradus latitudinis" gegen Null konvergiert, wie wir uns heute ausdrücken, war ORESME bekannt (55). Die Methode der „latitudines formarum" war bis zur Zeit DESCARTES wohl bekannt und verwendet; und es ist unzweifelhaft, dass sie auf DESCARTES prinzipiellen Einfluss ausgeübt hat, sowie auch auf die Entwickelung des Begriffs der Funktion. Die Schriften von SUISSET und ORESME waren BRADAWARDINA unbekannt, weil sie später verfasst wurden. „Tractatus de Continuo" war jedenfalls vor 1349 verfasst worden, wahrscheinlich nicht viele Jahre vorher. Das Werk von SUISSET entstand nach 1350, und von ORESME um ca. 1360. BRADWARDINA untersucht die „latitudo formarum" speziell nicht; er bedient sich dieses Begriffs nur

(52) Vgl. CUTRZE, *l.c.*; dann *Zs. f. Math. u. Phys.*, XIII, Suppl. und *Die math. Schriften des N.* ORESME, 1879. Vgl. auch CANTOR, *l. c.*

(53) In Jahren 1482, 1486, 1505, 1515.

(54) T, p. 198, Z. 1-3.

(55) T, p. 205, Anmerkung, 3°.

in seiner Polemik. Er beweist zuerst, dass „nullius forme suscipientis magis et minus remississimum gradum esse" (56). Daraus folgert er, dass im entgegengesetzten Falle die Indivisibilia (Atome) in jedem Kontinuum unmittelbar zusammenhängen müssten (57), und „tota latitudo talis forme tantum finitos gradus habere et omne continuum finita athoma continere" (58).

Nach dieser Vorbereitung beginnt BRADWARDINA die eigentliche Kritik verschiedener Anschauungen. Um seinen Ausführungen Allgemeinheit zu verschaffen, beweist er folgende Sätze (59) : „Si unum continuum habeat athoma inmediata et infinita uel finita, quodlibet sic habere". „Si unum continuum ex indiuisibilibus componitur secundum aliquem modum, materia et motus et quodlibet sic componi, et si unum non componitur ex athomis, nec ullum omnino".

In erster Reihe bekämpft BRADWARDINA die Anschauungen, nach welchen „continuum componitur ex indiuisibilibus inmediate coniunctis" (60). Das ist der Standpunkt des PYTHAGORAS und HENRICUS GOETHAELS. Die Methode BRADWARDINAS beruht darauf, dass er die gegebene These als wahr annimmt, und aus dieser Annahme Schlüsse in Gebieten verschiedener Wissenschaften zieht, welche sich als falsch erweisen. Deshalb beginnen die " conclusiones" mit den Worten „si sic". „Rationes geometrice" sind in dieser Polemik analog denen von ARISTOTELES und denen, welcher sich später die Araber und mittelalterliche Gelehrten wie z.B. DUNS SCOTUS, bedienten. „Si athoma in continuo inmediata ponantur, inmediata puncta centro circuli et quadrati siue cuiuslibet corporis punctis circumferentie circuli et quadrati lateris atque superficiei corporis exteris equaliter correspondent" (61). „Equaliter correspondere" das ist die heutige eineindeutige Abbildung zweier Mengen. Daraus folgt : „Si sic, cuilibet centro dato infinita puncta inmediate coniungi" (62) und ebenso „nulla duo puncta in superficie plana nec indiuisibilia in ullo continuo sibi sine medio coniungi ", „si sic, inter quelibet

(56) T, p. 166, Z. 3, c. 32; E, 26 r., Z. 19.
(57) *L. c.*, Z. 8, c. 33; E, *l. c.*, Z. 25.
(58) *L. c.*, Z. 22, c. 34; E, 26 v., Z. 14.
(59) T, p. 165, Z. 26, c. 30 und 31; E, 25 v., Z. 21.
(60) T, p. 166, Z. 42, c. 35; E, 27 r., Z. 8.
(61) T, p. 166, Z. 42, c. 35; E, 27 r., Z. 9.
(62) T, p. 167, Z. 7, c. 36; E, 27 r., Z. 18.

duo indiuisibilia continui cuiuscumque infinita eius indiuisibilia mediare" und endlich „omne continuum habere athoma infinita" (63), im Gegensatze zu PYTHAGORAS, PLATO und WALTER BURLEIGH. BRADWARDINA zieht noch andere geometrische Schlüsse, welche die Falschheit der Annahme beweisen sollen, z.B. : „Si sic, angulum rectum esse minimum angulorum, nec ullum angulum esse acutum, et omnes obtusos equales esse ad inuicem, nec aliquem angulum obtusum penitus reperiri" (64), „si sic, nullum triangulum nec circulum nec omnino angulum esse posse" (65), „si sic, lineee equedistantes concurrunt" (66). Um eine Probe BRADWARDINAS Beweisführung zu geben, zitieren wir den Beweis des Satzes, dass der rechte Winkel der kleinste sein müsste. Im Satze 38 (67) beweist BRADWARDINA, dass wenn man das Kontinuum als von unmittelbar vereinigten Atomen zusammengesetzt annimmt, jeder Punkt auf der Ebene nicht mehr als 8 unmittelbare Punkte besitzen kann. Nun führt BRADWARDINA den eigentlichen Beweis folgendermassen : (68) „Sit .a.b. recta et eius medium punctum .c., quam .d.e. secet perpendiculariter in .c. puncto, tunc inmediate circa .c. non sunt nisi 8 puncta per 38*am*, et 4 istorum sunt in 4 lineis, scilicet .a.c., .d.c., .b.c., e.c. Igitur reliqua, tantum sint 4, sunt in illis 4 angulis, igitur in quolibet istorum est tantum unum, et minor angulus quam unius puncti esse non potest, nec unus punctus esse minor alio per primam conclusionem".

BRADWARDINA beschränkt sich auf geometrische Schlüsse nicht, er zieht auch solche aus dem Gebiete der Naturwissenschaften (69). Diese Schlüsse betreffen vor allem die Bewegung (70), und kulminieren im allgemeinen : „Si sic, omnis motus et omnia agentia atque passa equari ad inuicem, excedere et excedi" (71). Auf dieser Grundlage kommt BRADWARDINA zu Sätzen : „Si

(63) T, p. 167, Z. 19, c. 37; E, 27 v., Z. 4.
(64) T, p. 167, Z. 43, c. 40; E, 28 r., Z. 8.
(65) T, p. 168, Z. 15, c. 41; E, 28 v., Z. 1.
(66) T, p. 168, Z. 26, c. 42; E, 28 v., Z. 14.
(67) T, p. 167, Z. 27, c. 38; E, 27, v., Z. 13.
(68) T, p. 168, Z. 1; E, 28 r., Z. 11.
(69) T, p. 168, Z. 31; E, 28 v., Z. 19.
(70) T, p. 168, Z. 31 bis p. 169, Z. 32, c. 43 bis 47; E, 28 v., Z. 19 bis 29 v., Z. 20.
(71) T, p. 169, Z. 33, c. 48; E, 29 v., Z. 20.
(72) T, p. 169, Z. 39, c. 49; E, 29, v., Z. 26.

sic, indiuisibile diuidetur" (72), und „si sic, continuum ex athomis integrari" (73).

Stellen wir jetzt die Sätze 53, 37, 34 und unsere Annahme zusammen, so sehen wir uns zum folgenden Schlusse berechtigt : „Si sic, omne continuum componitur ex indiuisibilibus infinitis et tamen ex finitis, et nec ex infinitis nec finitis, et componitur ex athomis et non componitur ex illis" (74). Deshalb „in nullo continuo athoma inmediate coniungi" (75).

Jetzt wendet sich BRADWARDINA gegen die Anschauung, dass das Kontinuum aus endlicher Anzahl von Atomen besteht, also gegen die Anschauung von PYTHAGORAS, PLATO und WALTER BURLEIGH. Wenn das Kontinuum aus endlicher Anzahl von Atomen zusammengesetzt ist, so muss vor allem der Satz gelten : „Sicud numerus athomorum unius continui ad numerum athomorum alterius, ita illud compositum ad aliud se habere." Daraus folgt : „Si aliquod continuum sit incommensurabile alteri et numerum incommensurabilem numero reperiri" (76) und dann allgemein „si sic, athoma in continuo inmediate iunguntur" und „omnia continua habere athoma infinita et ex athomis non componi" (77). Also schon die Arithmetik führt uns zum Widerspruch mit der Annahme.

Auch die Musik zeigt Widersprüche : „Si sic, debilissimus gradus soni se habet sicud unitas et ceteri se sine medio consequentes ut sequens series numerorum" (78). BRADWARDINA führt noch meherere ähnliche Konsequenzen aus diesem Gebiete an (79). Im Laufe seiner Ausführungen zitiert er den BOETIUS und den Peripatetiker ARISTOXENOS.

Aus der Geometrie gibt BRADWARDINA Sätze an, welche dem Standpunkte des PYTHAGORAS und WALTER BURLEIGH widersprechen, welche aber seine Anschauungen bekräftigen sollen (80). Diese Sätze weisen die Notwendigkeit der Annahme unendlicher Anzahl von Teilen eines Kontinuums nach. Ausserdem

(73) T, p. 170, Z. 42, c. 53; E, 31 r., Z. 3.
(74) T, p. 171, Z. 10, c. 55; E, 31 r., Z. 16.
(75) T, p. 171, Z. 28, c. 56; E, 31 v., Z. 11.
(76) T, p. 172, Z. 1, c. 57; E, 31 v., Z. 28.
(77) T, p. 172, Z. 36, c. 58; E, 32 v., Z. 15.
(78) T, p. 173, Z. 1, c. 59; E, 32 v., Z. 21.
(79) T, p. 173, Z. 14 bis p. 174, Z. 34 ,c. 60 bis 65; E, 33 r., Z. 9 bis 34 v., Z. 7.
(80) T, p. 174, Z. 35 bis p. 175, Z. 6, c. 66 bis 70; E, 34 v., Z. 8 bis Z. 22.

zieht BRADWARDINA gewisse Konsequenzen, analog denen, deren sich so gern die Scholastiker bedienten, welche die Atomistik verwarfen, wie ROGER BACO, DUNS SCOTUS, und früher noch ARISTOTELES und ALGAZEL, wie z.B. : „Si sic, periferiam circuli esse duplam dyametri, nam medietas periferie est equalis dyametro" (81). Der Beweis beruht auf der Herstellung eineindeutiger Abbildung zwischen der Menge der Punkte des Halbkreises und des Durchmessers, mit Hilfe der Senkrechten. — „Si sic, omnes circulorum periferie et omnes circuli sunt equales" (82). Diese Schlussweise, welche im Mittelalter wohl bekannt war (ROGER BACON, DUNS SCOTUS) stammt, wie BRADWARDINA selbst erwähnt, von ALGAZEL. — „Si sic, multi sunt circuli, centra non habentes" (83). „Si sic, angulus contingentie diuidetur per rectam (84)", und andere ähnliche.

Dann folgen analoge Schlüsse aus der Perspective, Astronomie, aus Naturwissenschaften (Physik), aus der Medizin, Metaphysik, Grammatik, Logik, Rhetorik und Ethik (85).

Um zu beweisen, dass das Kontinuum aus Atomen nicht besteht, muss BRADWARDINA noch beweisen, dass es aus unendlicher Anzahl derselben nicht besteht, er muss also noch die Unzulässigkeit der Anschauungen des HENRICUS GOETHAELS und LYNCOF darlegen. Dies geschieht analog zur früheren Beweisführung in den Sätzen 114 bis 136 (86), sowohl der Methode als auch dem Inhalte nach.

Jetzt nach Besprechung der drei wichtigsten Standpunkte, fasst BRADWARDINA die Resultate in folgenden drei allgemeinen Thesen zusammen (87) : „Nullum continuum ex indiuisibilibus infinitis componi. Hec conclusio sequitur ex predictis, et est contra illud, in quo summare Lyncof et Henricus conueniunt". „Si continuum componitur ex infinitis indiuisibilibus inmediatis, ad inuicem, componitur ex finitis. Unde mani-

(81) T, p. 175, Z. 27, c. 73; E, 35 r., Z. 18.
(82) T, p. 176, Z. 3, c. 74; E, 35 v., Z. 17.
(83) T, p. 176, Z. 15, c. 76; E, 36 r., Z. 6.
(84) T, p. 176, Z. 20, Corrolar zu c. 77; E, 36 r., Z. 11.
(85) T, p. 179, Z 31 bis p. 184, Z. 18, c. 92 bis 113; E, 39 r., Z. 14 bis 44 r. Z. 8.
(86) T, p. 184, Z. 24 bis p. 187^2, Z. 18; E, 44 r., Z. 16 bis Schluss des E.
(87) T, p. 187^2, Z. 15 bis Z. 26, c. 137-139; E, fehlt.

festum est : Nullum continuum ex infinitis indiuisibilibus inmediatis componi. Hec conclusio est specialiter contra conclusionem Henrici". „Si continuum componitur ex infinitis indiuisibilibus mediatis, componitur ex inmediatis. Unde : „Nullum continuum ex indiuisibilibus mediatis componitur. Hec conclusio specialiter est contra conclusionem Lyncof". Nach diesen drei Thesen folgt als Schluss der Satz, den wir am Anfang zitiert hatten, und welcher die Anschauung BRADWARDINAS zusammenfasst.

Nehmen wir nun positive Sätze BRADWARDINAS ins Auge. Vor allem beweist BRADWARDINA, dass jede Strecke in viele Strecken geteilt werden kann (88), sogar in unendlich viele (89). Dasselbe betrift die Winkel, die Kontingenzwinkel (90), die Dreiecke, die Kontingenzdreiecke (91) und die Flächen (92). Einige Sätze betreffen die Bewegung. Wenn ein Punkt oder ein Teil einer Geraden sich bewegt, bewegen sich auch alle ihre anderen Punkte und Teile (93). BRADWARDINA spricht auch von Kreisbewegung einer Strecke um einen ihrer Endpunkte (94). Es wird hier auch der allgemeine Satz bewiesen : „Quodcumque spatium finitum, quocumque tempore finito, posse uniformiter et continue pertransiri" (95), welcher für das Problem der Stetigkeit unentbehrlich ist. Der Satz 26 (96) drückt die Absolutheit der Zeit aus : „Si quid continue localiter moueatur, in eodem instanti non acquirit multos situs, nec in eodem situ in diuersis instantibus posse esse". Einige Sätze behandeln die Veränderung im allgemeinen (97).

Aus der Grundthese BRADWARDINAS, dass kein Kontinuum aus Atomen besteht, und aus dem Schlusse, dass jedes Kontinuum eine unendliche Anzahl von Kontinuen ähnlicher Art in sich

(88) T, p. 163, Z. 5, c. 20; E, 23 v., Z. 13.
(89) T, p. 174, Z. 35, c. 66; E, 34 v., Z. 8.
(90) T, p. 174, Z. 38, c. 67; E, 34 v., Z. 11.
(91) T, p. 174, Z. 42, c. 68; E. 34 v., Z. 16.
(92) T, p. 175, Z. 1, c. 69; E, 34 v., Z. 17.
(93) T, p. 163, Z. 26, c. 21; E, 24 r., Z. 13.
(94) T, p. 164, Z. 7, c. 22 f.; E, 24 v., Z. 15.
(95) T, p. 164, Z. 27, c. 24, corrol.; E, 25 r., Z. 8.
(96) T, p. 164, Z. 41, c. 26; E, 25 r., Z. 22.
(97) T, p. 165, Z. 23, c. 28, 29; E, Satz 28 fehlt, Satz 29 p., 25 v., Z. 18.

fasst, folgt, dass die Anschauung des DEMOCRITUS nicht haltbar ist. „Omnes igitur opiniones erronee specialiter reprobantur, preter opinionem Democriti, ponentem, continuum componi ex corporibus indiuisibilibus, que tamen per illam conclusionem et eius corrolarium sufficienter reprobatur (98)." BRAWARDINA kommentiert die Anschauung DEMOCRITS in folgender Weise (99). „Non tamen est ueri simile, quod tantus philosophus posuit aliquod corpus indiuisibile sicud in principio est diffinitum, sed forte per corpora indiuisibilia intellexit partes substantie indiuisibiles et uoluit dicere, substantiam componi ex substantiis indiuisibilibus..."

Interessant sind folgende Ausführungen, welche beweisen, dass im Mittelalter gewisse Grundprobleme der Geometrie, in unserem Falle im Zusammenhange mit dem Stetigkeitsproblem, ernst aufgefasst wurden. Es sei dabei wieder auf die heutigen Untersuchungen des Kontinuumsproblems hingewiesen. BRADWARDINA knüpft (100) an eine Bemerkung des AVERROES in seinem Kommentar an. Für AVERROES, als Parteigänger des ARISTOTELES, ist das Kontinuum ins Unendliche teilbar. Er wirft aber der Geometrie vor, dass sie „hoc non probat sed supponit, tamquam demonstratum in scientia naturali, potest igitur sic impugnare demonstrationes geometricas, prius factas, dicendo, geometriam ubique supponere, continuum ex indiuisibilibus non componi, et illud demonstrari non posse". BRADWARDINA ist jedoch der Meinung, dass diese Einwendung nicht am Platz sei, weil die Sätze und Beweise der euklidischen Geometrie sich auf diese Annahme nicht stützen. Dabei bemerkt er richtig „quia dato eius opposito, quelibet demonstratio non minus procedit, ut patet inductiue scienti conclusiones geometricas demonstrare" (101). „Uerumtamen Euclides in geometria sua supponit, quod continuum ex infinitis et inmediatis athomis non componitur, sed hoc inter suas suppositiones non ponit" (102). Bemerkenswert sind auch weitere Ausführungen BRADWARDINAS, aus welchen folgt, dass der Begriff der Unabhängigkeit bezw. Abhängigkeit der mathe-

(98) T, p. 187², Z. 39; E, fehlt.
(99) *L. c.*, Z. 41; E, fehlt.
(100) T, p. 188, Z. 1; E, fehlt.
(101) *L. c.*, Z. 9.
(102) *L. c.*, Z. 11.

matischen Sätze von gewissen Axiomen, welche heute in der Schule HILBERTS so respektiert wird, ihm nicht ganz fremd war (103). „Si falsigraphus dicat contrarium" — d.h. behauptete, dass das System der euklidischen Geometrie von diesem Postulat über die Struktur des Kontinuums abhängig ist — „et ponat aliqua linea ex duabus punctis componi, Euclides non potest, suam conclusionem primam demonstrare, quia super huius lineam non posset triangulus equelaterus collocari, quia nullum angulum haberet... Similiter si dicat falsigraphus, continuum ex athomis inmediatis componi, 4*am* suam conclusionem et 8*am*, non probat, ambe enim per suppositionem probantur. Similiter in probatione 3^e^. Iste autem conclusiones non demonstrantur per aliquas conclusiones priores sed ex inmediatis principiis ostenduntur; per has autem conclusiones relique demonstrantur et ex hiis tribus quasi tota geometria Euclidis deponet et in ipsa omnis alia geometria fundatur". BRADWARDINA ist überzeugt, dass alle diese Einwendungen nicht am Platz sind. „Est enim geometria sufficiens ostensiue et per inpossibile ex propriis principiis demonstrare, nullum suum continuum ex indiuisibilibus finitis mediatis componi" (104). Er zeigt sogar den Weg, wie dies bewerkstelligt sein könnte (105).

Am Schluss des Traktats untersucht BRADWARDINA „an indiuisibilia continuorum sint realiter distincta ut ponuntur" (106). Dieses Problem interessierte die Philosophen seit ARISTOTELES sehr intensiv. ARISTOTELES verneinte nicht, dass im Kontinuum die Punkte enthalten sind; sie existieren dort, aber nach ihm nicht in Wirklichkeit, „actu", sondern nur „potentia" (107). Das Kontinuum ist in infinitum teilbar, aber gleichfalls nur potentiell. Die Meinungen der Scholastiker waren in dieser Hinsicht geteilt. Die Mehrheit sogar liess die reale Existenz der unteilbaren Punkte im Kontinuum zu, wie THOMAS VON AQUINO, DUNS SCOTUS, welche den Kommentatoren des ARISTOTELES folgten, dann THEMISTIUS, SIMPLICIUS u. a. Die Nominalisten dagegen standen treu an Seite des ARISTOTELES. Wir finden auch Anschauungen,

(103) *L. c.*, Z. 12.
(104) T, p. 188, Z. 22.
(105) *L. c.*, Z. 24-38.
(106) T, p. 188, Z. 38.
(107) Phys. VI, 1, 231 *b*; III, 6, 207 *b*.

welche beide Gruppen einigen möchten; FONSECA (108) ist überzeugt, dass nur die Flächen, welche den Körper begrenzen, real existieren, nicht aber Punkte und Linien. Die reale Existenz der Punkte im Kontinuum, welche von vielen Scholastikern angenommen wurde, erfordert jedoch nicht, dass das Kontinuum aus Punkten b e s t e h e. In dieser Hinsicht bleiben viele Anhänger der Realität der Punkte auf dem Standpunkte des ARISTOTELES. Die Punkte verleihen dem Kontinuum das, was wir Stetigkeit nennen, aber sie verleihen ihm nicht Grösse. Deshalb lässt sich das Kontinuum aus Punkten nicht konstruieren. BRADWARDINA steht auf dem Standpunkte des ARISTOTELES. Für ihn ist die reale Existenz der Punkte (Atome) im Kontinuum unmöglich. Wäre sie möglich, so würde die materielle Substanz unteilbare Substanzen enthalten (109), würden die Atome des Kontinuums unmittelbar zusammenhängen (110), würde das Kontinuum aus Atomen bestehen (111). Das Kontinuum kann jedoch „sine aliquo indiuisibile continuante et finitante" existieren (112), weil „continuum non continuari nec finitari per talia, sed se ipso" (113). Die „continuantes" und „finitantes" Atome resp. Punkte sind diejenigen, welche andere miteinander verbinden, resp. an der Grenze des Gegenstandes sich befinden. Viele Scholastiker betrachteten die einen und die anderen als wirklich, BRADWARDINA behauptet, dass keine von ihnen wirklich sind. Der oben zitierte Satz schliesst den ganzen Traktat. BRADWARDINA gibt dazu noch folgende Bemerkung : „... quia prius ostendit qualiter continuum iam componitur, hic uult ostendere, qualiter non continuatur nec finitur, et qualiter continuatur et finitur... Si continuum non continuatur nec finitur per indiuisibilia talia, et non contingit assignare aliquod aliud, per quod continuum terminetur uel finiatur et continuum terminatur et continuatur, igitur continuatur et finitur se ipso".

Wieliczka b. Krakow (Polen). EDWARD STAMM.

(108) Comment. in Metaph., Arist., II, c. 13, qu. 6.
(109) T, p. 190, Z. 31, c. 145; E, fellt.
(110) T, p. 191, Z. 9, c. 146; E, fehlt.
(111) T, p. 191, Z. 32, c. 147; E, fehlt.
(112) T, p. 190, Z. 25, c. 144; E, fehlt.
(113) T, p. 192, Z. 7, c. 150 corrol.; E, fehlt.

Paravicus: a misprint, not a translator

It has been customary to speak of two different thirteenth-century Latin translations of the *Theisir* or *Tajsir* of AVENZOAR or IBN ZUHR; one by JOHN OF CAPUA of which there are manuscripts extant and which is said to be the better translation but never to have been printed, the other which is found only in the printed editions but is said to have been made in 1281 by a PARAVICI or PARAVICUS. This form of name has aroused my scepticism. It does not sound any too genuine although it has been unquestioningly accepted by such authorities as STEINSCHNEIDER, *Catalogus librorum hebraeorum in bibliotheca Bodleiana*, Berlin, 1852-1860, pp. 1213, 2773; GABRIEL COLIN, *Avenzoar, sa vie et ses œuvres*, Paris, 1911; GEORGE SARTON, *Introduction to the History of Science*, II (1931), 233; and the editors of the *Gesamtkatalog der Wiegendrucke*. It does not ring true to the thirteenth century. What other Latin translator of that time is known by a single appellation, and especially by one so odd? PARAVICUS what? or PARAVICUS of what? Not another translation is attributed to him. There is no contemporary mention of this name, nor is it cited in later medical manuscripts. There are other translations by JOHN OF CAPUA but none by PARAVICUS. He is first mentioned, so far as we know, in the initial rubric of the *editio princeps* of 1490 of the *Theisir* or *Tajsir*.

PARAVICUS appears to be a creation of the printer, a misprint making a strange name out of the common word, Patavinus, meaning "of Padua." Back in 1923 in *A History of Magic and Experimental Science*, II, 937, I described this translator of the printed version not as "Paravicus" but as a master of medicine from Padua. What reasons other than those already given are there for taking this review? First, the fact that, if we limit our consideration to the early editions of the fifteenth century, the name, "Paravicus," is found only in the *editio princeps* of 1490

and not in those of 1496 and 1497. Second, the fact that all these editions have at the close of the *Theisir* or *Tajsir* proper, before the *Antidotarium* begins, a colophon which the editors of the *Gesamtkatalog* seem entirely to have overlooked and which describes the Latin translator not as "Paravicus" but as "magister Pathavinus phisicus." Moreover, the wording of this colophon is such as to command more confidence than does that of the initial formula of the *editio princeps* in which PARAVICUS is named as translator. The colophon sounds as if copied directly from a manuscript. The initial statement of the *editio princeps*, or at least the last three-quarters of it, sounds like a restatement of the gist of the colophon by a printer or editor and loses something of the original precision and local color, which are marks of authenticity. I reproduce both passages below in order that the reader may judge of this for himself.

But now another question arises. Were there really two different thirteenth-century translators and translations of AVENZOAR's *Theisir*, or was JOHN OF CAPUA also a master of medicine at Padua, may 1281 be taken as the date of his translation, and is the printed version simply a careless rendition and corruption of it, inferior like so many other early printed editions to the best extant manuscripts of the text in question? To answer these queries, however, would require careful examination of the manuscripts themselves of JOHN OF CAPUA's translation and collation of them with the printed version. If the printed text is based on JOHN's translation, his prologue as translator has been entirely omitted in the editions. For the present I can only compare the opening words of the first chapter of the first tractate of AVENZOAR as reported by COLIN from JOHN's translation as found in MS 272 of the Faculty of Medicine, Paris, with those found in the edition of 1496:

MS	Printed text
Concordaverunt universi medici quod levitio ventris adiuvat continuitatem sanitatis...	Convenerunt omnes medici quod in habendo ventrem mollem conservatur sanitas...

Next I reproduce the introductory rubric of the *editio princeps* of 1490, of which there are copies in this country not only in

the Army Medical Library at Washington and John Crerar Library of Chicago, as noted in the *Gesamtkatalog*, concerning which the librarians of those collections, Major EDGAR ERSKINE HUME and J. CHRISTIAN BAY respectively, have courteously answered my inquiries, but also in the Jewish Theological Seminary of New York, which was not mentioned in the *Gesamtkatalog* because acquired only recently in 1932. After it comes the colophon found not only in the *editio princeps* but in a longer form in that of 1496, which I have consulted at the library of the New York Academy of Medicine, and in that of 1497, of which there is a copy at the library of the College of Physicians in Philadelphia concerning which its librarian, Dr. W. B. MCDANIEL, 2nd, has very kindly answered my inquiry. The explanation of the longer form is that the statement of date which appeared in the introductory rubric in the *editio princeps* is a part of the colophon in the editions of 1496 and 1497.

INTRODUCTORY RUBRIC
(found only in the edition of 1490)

In nomine domini amen. Incipit liber theicrisi dahalmodana vahaltadabir cuius est interpretatio rectificatio medicationis et regiminis : editus in arabico a perfecto viro abumaruan Auenzohar et translatus de hebraico in latinum venetiis a magistro parauicio physico ipso sibi vulgarizante magistro iacobo hebreo. Anno domini Jesu christi M.cc.lxxx. primo mense augusto die iovis in meridie secundo ducante venetiis viro egregio et preclaro domino Johanne dandolorum secundo anno sui ducatus : anni autem regni 679 menses iiii dies ii.

COLOPHON
(Common to all three editions of 1490, 1496, 1497, but a shorter form is used in that of 1490. I give it first, then the fuller form found in the edition of 1496.)

Completus est liber theiscir almudanar cum laude dei : editus in arabico a discreto viro Abumeron in practica et operatione medicine excellentissim' fidelis regis Auenzoar translatus venetiis in confinio sancti Saluatoris de hebraico in latinum a magistro

Pathauino phisico ipso sibi vulgarizante magistro Jacobo hebreo in medicina et aliis scientiis plurimum erudito.

LONGER FORM

Completus est liber theyscir almudanar cum laude dei editus in arabico a discreto viro Abymeron in practica et operatione medicine excellentissimo fideli regis Aynçoar translatus Venetiis in confinio sancti Salvatoris de hebraico in latinum a magistro Pathavino physico ipso sibi vulgariçante magistro Iacobo hebreo in medicina et aliis scientiis plurimum erudito. Currente anno domini nostri Yesu Christi millessimo ducentesimo octuagesimo-primo die iovis que fuit vigesimaprima augusti in meridie Ducante viro egregio et preclaro Domino Ioanne dandulo sui ducatus anno secundo Annis arabum 679 mensis quarti diebus quinque.

This statement of the date of translation is more convincing than that in the introductory rubric of the *editio princeps*, giving the day of the month which has been omitted in the other, although both state the day of the week, Thursday, which seems idle without the day of the month. On the other hand, August 21, 1281 fell on a Thursday, as the longer colophon states. Moreover, the statement as to the number of Arabic years elapsed is also correct (1), whereas any attempt to interpret the " anni regni " of the shorter form as years since the foundation of the Venetian republic is difficult and unconvincing. Again " excellentissimo fideli " of the longer form of colophon is grammatically superior to " excellentissim(us) fidelis " in the 1490 form. Thus we are impelled to the conclusion that the editions of 1496 and 1497 which lack the introductory rubric have preserved the more original and genuine form of the colophon, which has been curtailed in the *editio princeps* in its proper place but has been transposed and jumbled by some careless editor or printer to form the introductory rubric which marks the edition of 1490 alone and which is our only ground for calling the translator Paravicus instead of a master of medicine of Padua.

Columbia University, New York. LYNN THORNDIKE.

(1) According to WOLSEY HAIG's *Comparative Tables of Mohammedan and Christian Dates*, 1932, the year 679 of the Hegira began on May 3, 1280 and closed on April 21, 1281. From April 22 to August 21 inclusive would be 122 days, while four Arabic months and five days would give 123.

Biringuccio und Agricola

Auf S. 121-122 des 24. Bandes der *Isis* macht Herr Prof. J. R. PARTINGTON darauf aufmerksam, dass die an zwei Stellen meiner Schriften (1) wiedergegebene Annahme, BIRINGUCCIO habe in seiner " Pirotechnia " aus dem Hauptwerke AGRICOLA's geschöpft, auf Verwechslung beruhe, und hierin ist er im Rechte, denn jene erschien bereits 1540, diese aber (" De re metallica " = Metallurgie) erst 1556. Wenn er jedoch hieran die Folgerung knüpft, " es ist demgemäss gänzlich widerlegt, dass die deutschen Technologen zur fraglichen Zeit von irgendwelcher leitender Bedeutung für Europa gewesen seien," so geht diese doch wohl zu weit und dürfte daher nicht unwidersprochen bleiben. Es sei daran erinnert, dass BIRINGUCCIO (1480-1539), wie MIELI's ausgezeichneter (leider noch unvollendeter) Neuausgabe zu entnehmen ist, sich schon 1507 über Friaul und Kärnten auch nach Deutschland begab, und während der Jahre 1526-29 eine zweite grössere Reise dahin unternahm, Fahrten, " die ihm ermöglichten, praktische Kenntnisse der Künste zu erlangen, die er später in der Pirotechnia beschrieb " (2). In diesem Werke, das vermutlich zwischen 1530 und 1535 abgeschlossen ist (3), sagt er selbst—und MIELI setzte diese Worte seiner Ausgabe als Motto voran,—" narrando, quanto ho veduto..." (" erzählend, was alles ich gesehen habe "), stellt also die Wichtigkeit dieses Gesehenen neben der seiner eigenen Leistungen ausdrücklich fest (4). Dass das Bergwesen, insbesondere aber die Gewinnung und Verarbeitung der Metalle (u. a. der Geschützguss !) in

(1) " Entstehung und Ausbreitung der Alchemie " (Berlin, 1919), I. S. 598; *Beiträge zur Geschichte der Naturwissenschaften und der Technik* (Berlin, 1923) S. 136.

(2) Bari 1914, Vorr., S. 8, 10.

(3) Ebenda S. 12.

(4) Lib. III, cap. 4. Vergl. auch die Vorrede in JOHANNSEN's hervorragender deutscher Übersetzung der Pirotechnia (Braunschweig, 1925), sowie dessen Biographie BIRINGUCCIO's in BUNGE's *Buch der grossen Chemiker* (Berlin, 1929), I, 70.

Deutschland schon geraume Zeit vor 1500 auf grosser Höhe standen, bestätigt nicht nur die umfangreiche neuere Literatur, sondern auch die reichhaltige ältere, die durchweg auf den Überlieferungen einer längeren Vergangenheit fusst; der kurze Hinweis auf beide dürfte an dieser Stelle genügen (5). Aus der älteren schöpfte, in Ergänzung seiner eigenen Erfahrungen, auch AGRICOLA (1494-1555), dessen " Metallurgie " zwar erst 1556 erschien, aber wohl schon um 1550 vollendet, und noch erheblich früher in Ausarbeitung begriffen war; sein erstes metallurgisches Buch : " Bermannus, sive de re metallica," kam sogar schon 1530 heraus, also zur nämlichen Zeit, zu der BIRINGUCCIO das seinige abzufassen begann (6). Damals waren deutsche bergbauliche und metallurgische Erzeugnisse mannigfacher Art in Italien längst vorteilhaft bekannt und hochgeschätzt, wird doch, um nur ein einziges Beispiel anzuführen, auf dem so anspruchsvollen Markte Venedigs das deutsche Antimon als das beste angeführt (7). An dem hohen Stande und der anerkannten Bedeutung des deutschen Berg- und Hüttenwesens zur besagten Zeit ist also nicht wohl zu zweifeln.

(Halle a.S., 1936.) EDMUND O. VON LIPPMANN.

Professor LIPPMANN, who with his usual courtesy allowed me to see his note, has brought out some interesting material for the history of technology. He has, in his writings, insisted on the important part taken by Italy in early metallurgy—to take one example, in the development of the bronze industry, and also in the transmission of alchemy from the Saracen civilisation to Europe. The case is similar in later technology. The method of bell casting given by BIRINGUCCIO is quite different from the earlier method, and if we must give Germany the palm for the manufacture of arms, we must remember that the arts of peace are no less renowned than those of war. An adequate study of the interrelations of Italy and Germany in technology in the sixteenth century has still to be made.

J. R. PARTINGTON.

(5) Vergl. z. B. DARMSTAEDTER, *Berg-, Probier-, und Kunstbüchlein* (München, 1926).

(6) Vergl. DARMSTAEDTER *Agricola* (München, 1926).

(7) " Alchemie " I, S. 639.

Epitomes of Pliny's Natural History in the Fifteenth Century

The popularity of PLINY's *Natural History* during the fifteenth century is attested by several epitomes of it in manuscripts of that century. At Balliol College, Oxford, there is preserved an epitome of the *Natural History* by a RETINALDUS who further describes himself as "a servant of Christ."

Balliol 146 (A), fols. 31-106, prologue opening, "Retinaldus ego servus Christi Plinii libros revolvens..." while the text opens and closes, "Plinius secundus novem menses.../... nec est ulla fraus vite lucrosior."

The humanist PLATINA also composed an epitome which seems not to have been printed but is found in a manuscript at the British Museum.

Harley 3475, 15th century, paper, imperfect, breaking off in the fifth book: C. Plinii secundi Historiae Naturalis Epitome, cum epistola Platinae ad Masseum.

Finally, a manuscript at the Escorial has an epitome by LUDOVICUS DE GUASTIS addressed to PAULUS GUINISIUS, lord of Lucca, i.e. to PAOLO GUINIGI, despot of Lucca from 1400 to 1430. Presumably this LOUIS is identical with the grammarian, LUDOVICUS DE GUASCHIS, whose commentary was printed with the *Doctrinale* of ALEXANDER OF VILLADEI at Milan in 1481 and thrice at Venice in years immediately following: see Hain I, 743-46.

Escorial g. III. 2, 15th century, fols. 53-120: Epitoma Plinii Secundi in historia naturali abbreviatum per dominum Ludovicum de Guastis ad illustrem principem Paulum Guinisium dominum Lucensem incipit, "Etsi compertum habeo, illustris princeps Paule, tot in orbe terrarum librorum esse volumina. ."

Previous centuries had had, of course, the Excerpts from the Natural History of PLINY made by ROBERT OF CRICKLADE in the twelfth century. But apparently the fifteenth century felt a need for further works of that sort.

Columbia University. LYNN THORNDIKE.

Marco Antonio de Dominis and his Explanation of the Rainbow

The correct elementary explanation of the rainbow was given by QUṬB AL-DĪN and THEODORIC OF FREIBURG as early as the beginning of the fourteenth century (1); they were the first to show that the primary bow is caused by two refractions and one reflection of the sun's rays, and the secondary bow by two refractions and two reflections. ANTONIO DE DOMINIS, archbishop of Spalatro, is usually believed to have discovered these results independently, and to have published them in his scientific tract, *De radiis visus et lucis* (Venice, 1611). The object of this paper is to examine his theory of the rainbow, and to give some account of the controversy which arose concerning it.

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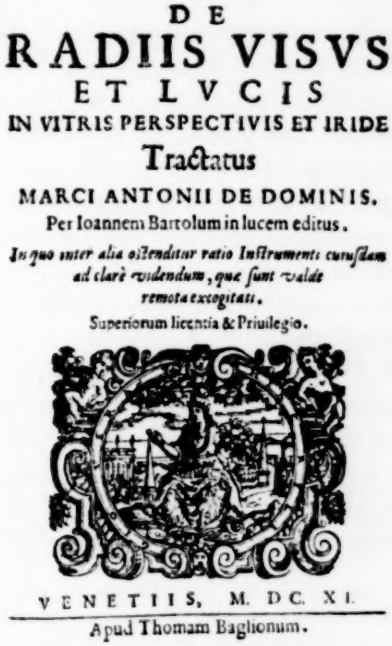
MARCO ANTONIO DE DOMINIS (2) was born in 1566 at Arbe, an island off the Dalmatian coast. He was descended from a distinguished Italian family, and became a brilliant pupil of the University of Padua. He entered the order of the Jesuits, and even during his noviciate was appointed professor of mathematics at Padua, and of logic and rhetoric at Brescia. He was exceedingly ambitious, and became successively bishop of Segni and archbishop of Spalatro. Involved in a dispute with the pope, and probably fearing that future preferment would be denied him, he decided to join the Anglican church. He arrived in England in 1616, and was received with great honour. A few months later JAMES I.

(1) See G. SARTON, *Introduction*, vol. 2, p. 23. QUṬB AL-DĪN's work may date from the end of the thirteenth century.

(2) There is no adequate biography of DE DOMINIS. Brief accounts are given in the *Dictionary of National Biography*, and in A. TAMARO, *La Vénétie Julienne et la Dalmatie*, Rome 1918-19, vol. 3, pp. 266-70. For the life of DE DOMINIS in England, see H. NEWLAND, *The life and contemporaneous church history of Antonio de Dominis*, Oxford and London, 1859.

appointed him dean of Windsor. In 1617 he began the publication of his most important theological work, *De republica ecclesiastica*. On the succession of GREGORY XV. to the papacy, DE DOMINIS opened secret negotiations for returning to the Roman church. Assured that a full pardon would be granted him, he proceeded to Rome in 1622, but was soon afterwards imprisoned


DE
RADIIS VISVS
ET LVCIS
IN VITRIS PERSPECTIVIS ET IRIDE
Tractatus
MARCI ANTONII DE DOMINIS.
Per Ioannem Bartolum in lucem editus.
In quo inter alia ostenditur ratio Instrumenti cuiusdam ad clarè videndum, quæ sunt valdè remota excogitati.
Superiorum licentia & Priuilegio.
VENETIIS, M. DC. XI.
Apud Thomam Baglionum.

Courtesy of British Museum.
The word Tractatus on l. 4 measures 3 cm.

by the Inquisition for heresy. He died in captivity in 1624; after his death his body and his books were publicly burnt (3).

His character was judged unfavourably by all his contemporaries. He seems to have been quite unscrupulous, and it is almost impossible to suppose that either of his so-called conversions could have been genuine.

In view of the attempts occasionally made to regard DE DOMINIS

(3) It is sometimes erroneously stated that DE DOMINIS actually died at the stake (e.g. J. J. FAHIE, *The scientific works of Galileo*, in *Studies in the history and method of science*, Oxford, 1917-21, vol. 2, p. 270).

as a martyr of science, it is perhaps necessary to point out that there is no evidence that his scientific work led in any way to his condemnation by the Inquisition. His theory of the rainbow was certainly never considered heretical (4). It is true, however, that all his works were placed on the *Index librorum prohibitorum*.

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In addition to his numerous theological works, DE DOMINIS wrote two scientific tracts. Apparently he little valued them, as he did not publish either of them himself. *Euripus, seu de fluxu et refluxu maris* was published posthumously at Rome in 1624. The other tract, *De radiis visus et lucis in vitris perspectivis et iride*, was published by his friend GIOVANNI BARTOLO at Venice in 1611. It is a small volume of eighty-seven pages, poorly printed, and now extremely scarce (5). In the preface BARTOLO says that the work is based on notes prepared by DE DOMINIS for his lectures at Padua and Brescia twenty years before; but he adds that DE DOMINIS himself had revised these notes and inserted an explanation of the newly-invented telescope (6).

The first part of the book is very elementary, and derived mainly from WITELO's *Perspectiva*. The explanation of the Galilean

(4) This has been asserted by F. W. WESTAWAY in *The endless quest*, London, 1934, p. 159.

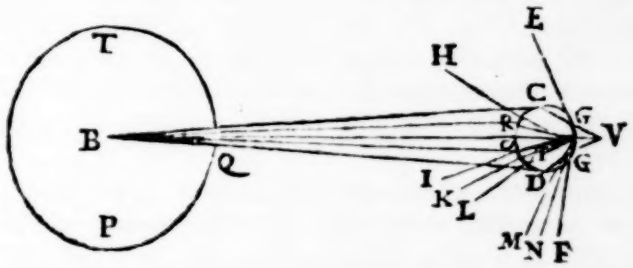
(5) N. J. POISSON, writing in 1671, says that he was unable to procure a copy although he made every effort to do so (*Commentaire ou remarques sur la méthode de Mr. Descartes*, Paris, 1671, p. 209). Several later writers have alluded to the unusual rarity of this work, which may indicate that some attempt was made to suppress it. C. BERTACCHI refers to a second edition of Paris 1623, but this is almost certainly an error (*Meteore luminose*, Turin, 1883, p. xiv). Chapters 9 and 13 are reprinted in G. LIBRI's *Histoire des sciences mathématiques en Italie*, Paris, 1838-41, vol. 4, p. 436-454.

(6) BARTOLO implies that DE DOMINIS was acquainted very early with the principle of the telescope : " Non eram nescius eum in iuventute omnes publice professum fuisse partes Philosophiae, ac proinde etiam Mathematicis rebus splendorem maximum addidisse; sciscitari saepius placuit, quidnam de novo Instrumento illo sentiret, quod nuper ad inspicienda quae sunt remotissima a Nostrate Viro insigni Mathematico GALILEO in lucem editum ferebatur, et Venetiis potissimum publicatum." DE DOMINIS also remarks : " Id enim quemadmodum maxima admiratione affecit, et afficit plurimos ita mihi certe, qui in perspectivis ante multos, sed per multos etiam annos delectationis causa mentem exercui, nulli prorsus fuit admirationi, sed cum primum illud vidi (erat autem valde imperfectum) effectum duorum vitrorum aperte cognovi." *De radiis visus*, pp. 37-38.

telescope (pp. 34-43), though erroneous, deserves some attention. One passage appears designed to cast doubts on GALILEO's claims for his telescope published in *Sidereus Nuncius* in 1610 : " An vero tanta perfectio possit esse huius instrumenti, ut visibilia vigecuplo maiora appareant, ut aliqui tradiderunt, et plurimum gloriantur, relinquo aliis considerandum : nam meum exactissimum instrumentum, vix ad quintuplum rem facit excrescere " (7). In another passage DE DOMINIS suggests the use of draw-tubes : " Melius tamen erit instrumentum si uno, pluribusve nodis ad mobilitatem discretum connectatur, quam si sit unicum, integrum, et continuum : nimirum ut possit pluribus visibus adaptari, cum iam ostenderim distantiam omnibus oculis non eandem inservire " (8). Dr. SINGER believes that DE DOMINIS may have been indebted for some points of his explanation of the telescope to KEPLER's *Dioptrice*, which was also published in 1611 (9). I can, however, find no evidence to support this; DE DOMINIS appears to have been quite ignorant of the possible application of two convex lenses.

* * *

A brief outline of the theory of the rainbow is given by DE DOMINIS at the end of Chapter 4 of *De radiis visus* and is here quoted in full. We reproduce the figure from the original (p. 14).



" Corpus globosum sive sphoericum diaphanum supradictum, plenum sive solidum, praeterquam quod reflectit ex sui superficie convexa radios modo dictos, facit aliam reflexionem lucis, permistam cum aliqua

(7) *De radiis visus*, pp. 38-39.

(8) *De radiis visus*, p. 38.

(9) C. SINGER, *Steps leading to the invention of the first optical apparatus*, in *Studies in the history and method of science*, Oxford, 1917-21, vol. 2, p. 413.

refractione : nam radius lucis ex centro corporis lucidi B penetrat irrefactus [irrefractus] recta usque ad V per centrum A cum sit perpendicularis; radii vero BC et BD franguntur in C et D ad perpendicularem, per tradita supra cap. 2 supposit. 11, et penetrant similiter fundum G ulterius in V eoque multam lucem congregant simul cum radiis interioribus BR, BO, qui et ipsi fracti in punctis R et O perveniunt circa punctum G in fundo globi A, quod et faciunt reliqui radii ex B quicunque incidunt in superficiem convexam totam a C usque ad D : sed interim omnes radii fracti congregati circa fundum G non modo partim penetrant et uniuntur ad punctum V, ubi et ignem possunt accendere, sed etiam bona ex parte cum eadem lucis intensione ob dictam aggregationem reflectuntur a fundo G. Qui fundus G varias facit huius lucis multiplicatae reflexiones, servata lege reflexionum ex sphoerico concavo; sed tamen nonnihil variata, quia est reflexio post iam dictas refractiones; et quia non modo reflectuntur radii incidentes in globum A ex centro corporis lucidi B, sed etiam infiniti alii ex reliquo corpore lucido et valde magno ut est sol, quicunque videlicet ex T et P et reliqua circumferentia TQP egrediuntur. Quam varietatem nunc explicare demonstrationibus non est operae pretium : satis est me experimentis clarissimis comperisse, in phiala aqua plena, et globulis vitreis aqua similiter plenis a me ad hunc tantum effectum perfici curatis, ex fundo G opposito soli directe, praeter refractionem quae fit in V, duplices fieri reflexiones; alias statim per latera versus F et E circulariter, alias vero versus solem prope perpendicularem BA ad partem anteriorem, versus H et I similiter circulariter; et non per unam solam lineam indivisibilem, sed per plures utrobique, cum aliqua latitudine, ut sunt in priori reflexione GF, GN, GM, in altera vero GI, GK, GL; quae latitudo oritur partim ex refractionibus quae intra globum fiunt, cum aggregatione plurimum radiorum; partim ex magna latitudine corporis luminosi PQT ut paulo ante dicebamus " (10).

This summary, which contains several obvious errors, is developed at considerable length in later chapters of the book (pp. 43-78). It is there explained that the rays GF, GN, and GM form the primary bow, while the rays GL, GK, and GI form the secondary bow. According to De Dominis, the ray GF will appear red, GN green and GM blue; in the secondary bow the order of the colours is reversed.

It is clear from the above quotation, or even from the diagram

(10) *De radiis visus*, pp. 13-14.

which accompanies it, that DE DOMINIS was entirely mistaken in his explanation of the secondary rainbow; he certainly had no idea that it was caused by two refractions and two reflections of the sun's rays. Moreover, his explanation of the primary rainbow is incomplete, since he overlooks the fact that the rays must be refracted on emerging from the raindrop. Strangely enough, he suggests that this may occur in the case of the secondary bow, though he does not assign any reason (11).

It is necessary to insist on these fundamental errors, since DE DOMINIS is still credited in most standard works of reference with the correct explanation of both the primary and secondary rainbows (12). All that can justly be claimed for DE DOMINIS is that he gave a rather better explanation of the primary rainbow than any published before 1637, when DESCARTES gave the correct elementary theory of both bows (13). In spite of assertions to the contrary, DESCARTES could not have been greatly indebted to the work of DE DOMINIS; indeed, it is quite probable that he had never even seen it.

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When the *De radiis visus* was published in 1611, it does not seem to have attracted much attention. It was not, however, entirely forgotten. In 1671 N. J. POISSON thought it necessary to reply to "certain Italians" who had accused DESCARTES of plagiarism from DE DOMINIS (14). Several years later LEIBNIZ repeated the accusation (15), and a further reply was made by

(11) "... partim fortasse ex aliqua fractione in egressu ex globulo." *De radiis visus*, p. 65.

(12) E.g. *Encyclopædia Britannica*, 14th ed., art. Rainbow. F. CAJORI attributes "the correct outline of the theory" to DE DOMINIS (*A history of physics*, New York, 1929, p. 96).

(13) R. DESCARTES, *Discours de la méthode... Les météores*, Discours 8, Paris, 1637.

(14) N. J. POISSON, *Commentaire ou remarques sur la méthode de Mr. Descartes*, Paris, 1671, p. 209. I have not been able to identify the Italian writers .

(15) BAILLET gives the reference : "Leibn. Epist. Ms. 1689," which I cannot trace. In *Notata quaedam circa vitam et doctrinam Cartesii*, LEIBNIZ remarks : "Circa Iridem a M. ANTONIO DE DOMINIS non parum lucis accepit." (LEIBNIZ, *Opera omnia*, Geneva, 1768, vol. 5, p. 394). See also : LEIBNIZ, *Nouvelles lettres et opuscules inédits*, Paris, 1857, p. 17. In a letter to NICAISE, dated 1696, LEIBNIZ attacked DESCARTES even further : "Si Mr. D'AVRANCHES fait réimprimer un jour sa censure sur la Philosophie Cartésienne, je pourrois lui communiquer

A. BAILLET (16). Both POISSON and BAILLET contended that DESCARTES was not obliged to mention the names of all those who had written before him on the subject.

The controversy thus begun would probably have ended here, had not NEWTON revived it in 1704 by a passage in his *Opticks:* "And hence it is now agreed upon, that this Bow is made by Refraction of the Sun's Light in drops of falling rain. This was understood by some of the Antients, and of late more fully discover'd and explain'd by the famous ANTONIUS DE DOMINIS Archbishop of *Spalato*, in his book *De Radiis Visus et Lucis*, published by his Friend BARTOLUS at *Venice*, in the Year 1611, and written above 20 Years before. For he teaches there how the interior Bow is made in round Drops of Rain by two Refractions of the Sun's Light, and one Reflexion between them, and the exterior by two Refractions, and two sorts of Reflexions between them in each Drop of Water, and proves his Explication by Experiments made with a Phial full of Water, and with Globes of Glass filled with Water, and placed in the Sun to make the Colours of the two Bows appear in them. The same Explication DES-CARTES hath pursued in his *Meteors*, and mended that of the exterior Bow" (17).

As we have seen, NEWTON is certainly incorrect in saying that DE DOMINIS discovered that the secondary rainbow is formed by two refractions and two reflections of the sun's rays. Moreover, his final sentence appears to support the charge of plagiarism against DESCARTES, who gave his theory as wholly original (18).

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quelques choses curieuses pour l'augmenter, et entre autres une remarque de feu Mr. HUYGENS, qui a découvert que le fondement de ce que Mr. DES CARTES a donné sur l'Arc-en-Ciel au delà de MARC ANTOINE DE DOMINIS, a été pris d'un endroit de l'incomparable KEPLERUS." (LEIBNIZ, *Opera omnia*, Geneva, 1768, vol. 5, p. 547). I do not know of any edition of P. D. HUET's *Censura philosophiae cartesianae* subsequent to 1694. LEIBNIZ may possibly be referring to a letter (then unpublished) written by KEPLER to HARRIOT in 1606 (See *Epistolae ad J. Kepplerum*, Frankfort, 1718, pp. 374-376). But KEPLER's explanation of the primary rainbow is not altogether correct, and he does not attempt to explain the secondary bow.

(16) A. BAILLET, *La vie de Monsieur Des-Cartes*, Paris, 1691, vol. 2, p. 540.

(17) I. NEWTON, *Opticks*, London, 1704, Book I, Pt. II, Prop. 9. (Ed. 1931, p. 169).

(18) A later reference to DE DOMINIS in the *Opticks* is equally misleading: "This Explication of the Rain-bow is yet further confirmed by the known Experiment (made by ANTONIO DE DOMINIS and DES-CARTES) of hanging up anywhere

NEWTON's marked appreciation of the work of DE DOMINIS has aroused considerable comment. A recent suggestion is that a study of the *De radiis visus* may have originated NEWTON's interest in atmospheric optics (19). This is very improbable, since in the *Lectiones opticae*, 1669-1671 (published at London in 1729) NEWTON repeatedly refers to DESCARTES' explanation of the rainbow, but not once to the work of DE DOMINIS. One may therefore conclude that NEWTON did not become acquainted with that tract until some time after 1671.

It is more difficult to decide whether NEWTON was genuinely mistaken in his remarks on DE DOMINIS. J. B. BIOT boldly affirmed that NEWTON was always unfair to DESCARTES, and alluded to this passage in the *Opticks* as an illustration (20). On the other hand, GUILLAUME LIBRI, while admitting that NEWTON was incorrect, thought it difficult to suspect him of injustice (21). However, NEWTON must have studied the work of DE DOMINIS with some care, since he refers to the preface by BARTOLO, and to the experiments which DE DOMINIS claimed to have made with " a phial full of water, and with globes of glass filled with water." He was therefore almost certainly aware that the work did not merit the praise he bestowed on it; even a cursory glance at the diagrams should have convinced him that DE DOMINIS was ignorant that the secondary rainbow is made " by two refractions and two sorts of reflexions between them in each drop of

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in the Sun-shine a Glass Globe filled with Water, and viewing it in such a posture, that the Rays which come from the Globe to the Eye may contain with the Sun's Rays an Angle of either 42 or 50 degrees." (*Opticks*, ed. 1931, p. 176). Yet DE DOMINIS did not obtain these results from his experiments; he does indeed say that the primary bow disappears when the sun's elevation exceeds 42°, but he does not pretend that he himself observed this : " ... quod fit, secundum quorundam observationes, quando Sol est elevatus per 42 gradus; quos si superest, nihil Iridis super horizontem remanet." (*De radiis visus*, p. 66).

(19) I. NEWTON, *Opticks*, ed. London, 1931, Preface by E. T. WHITTAKER, p. xii. D. M. TURNER, *The book of scientific discovery*, London, 1933, p. 98.

(20) " Tout lecteur impartial qui voudra recourir aux livres originaux, verra, d'une manière incontestable, que la théorie de DESCARTES est exacte et complète quant à la cause de l'arc, à sa formation et à sa grandeur... Le livre de DE DOMINIS ne contient absolument que des explications tout à fait vagues, sans aucun calcul et sans aucun résultat réel." *La biographie universelle*, Paris, 1843-66, vol. 30, p. 368, note.

(21) G. LIBRI, *Histoire des sciences mathématiques en Italie*, Paris, 1838-41, vol. 4, p. 149.

water." NEWTON was a careful writer, and he may quite well have inserted these words in order to belittle DESCARTES' achievement.

Whatever may have been NEWTON's motives, his statements concerning DE DOMINIS were certainly unfortunate, as they were generally accepted without question. CHRISTIAN VON WOLF, in his *Mathematisches Lexicon* (1716), even went so far as to say that DESCARTES merely republished the explanation given by DE DOMINIS (22). PEMBERTON followed more closely to NEWTON's words (23), and VOLTAIRE evidently had PEMBERTON's book in view when he alluded to DE DOMINIS in the *Lettres philosophiques* (24). The belief that DESCARTES was greatly indebted to DE DOMINIS, and that he was unjust in not acknowledging his obligations, is still widely held (25).

NEWTON's statements did not, however, pass unchallenged. A careful examination of the theory of the rainbow put forward by DE DOMINIS was made by J. R. BOSCOVICH in 1747; he showed clearly its more important errors (26). Similar views were expressed by JOSEPH PRIESTLEY in 1772 (27). In 1758 J. E. MONTUCLA bitterly complained of the reputation which DE DOMINIS had acquired, and hinted that it was due to a conspiracy by English and Italian writers to depreciate DESCARTES' scientific work (28). By this time national prejudices were aroused, and later writers on DE DOMINIS usually took an opportunity either to attack or defend DESCARTES (29); very few troubled to consult the original

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(22) I have not seen this work. I quote from the notes of J. R. BOSCOVICH to C. NOCETI's *De iride*, Rome, 1747, pp. 40-41.

(23) H. PEMBERTON, *A view of Sir Isaac Newton's philosophy*, London, 1728, p. 394.

(24) VOLTAIRE, *Lettres philosophiques*, Amsterdam, 1734, Lettre 16, Sur l'optique de Mr. NEWTON. VOLTAIRE did actually consult the *De radiis visus*, but apparently not until 1735. (See *Lettres philosophiques*, ed. G. LANSON, Paris, 1909, vol. 2, p. 49).

(25) See e.g. C. CANTU, *Storia universale*, Turin, 1838-46, vol. 16, p. 574. S. GLIUBICH, *Dizionario biografico*, Vienna and Zara, 1856, p. 120. I. B. HART, *Makers of science*, London, 1923, p. 137.

(26) C. NOCETI, *De iride et aurora boreali*, Rome, 1747, Notes by J. R. BOSCOVICH, pp. 40-45.

(27) J. PRIESTLEY, *The history and present state of discoveries relating to vision, light, and colours*, London, 1772, vol. 1, pp. 50-54.

(28) J. E. MONTUCLA, *Histoire des mathématiques*, Paris, 1758, vol. 1, p. 631.

(29) Among those who defended DESCARTES are : G. TIRABOSCHI, *Storia*

works. The most curious book of all in this obscure controversy is the *Meteore luminose* of Dr. COSIMO BERTACCHI, published at Turin in 1883. This is an extravagant eulogy of DE DOMINIS, and a violent attack on the French supporters of DESCARTES. The following sentence is typical: "Certamente molti pregiudizi ed un male inteso, ostinato orgoglio nazionale degli scrittori francesi, avvalorato pur sempre dalla complice ignavia dei nostri, ha potuto lungamente avviluppare in un profondo e vituperoso oblio il merito scientifico di questo illustre Italiano " (30). The arguments advanced by BERTACCHI in favour of DE DOMINIS are worthless. Happily, his work did not lead to further recriminations.

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My principal conclusions are therefore : 1. DE DOMINIS did not give the correct elementary theory of the rainbow; his explanation of the primary bow is incomplete, while that of the secondary bow is quite erroneous. DESCARTES, who gave the correct explanation in 1637, could not have been indebted on any essential point to DE DOMINIS. 2. NEWTON's statements in the *Opticks* concerning DE DOMINIS are incorrect; they were probably inserted in order to depreciate the importance of DESCARTES' work.

London. R. E. OCKENDEN.

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della letteratura italiana, ed. Milan, 1822-26, vol. 8, p. 336. *Dictionnaire des sciences mathématiques*, ed. A. S. DE MONTFERRIER, Paris, 1835-40, vol. 1, art. DOMINIS. *La biographie universelle*, Paris, 1843-66, vol. 11, art. DOMINIS.

(30) C. BERTACCHI, *Meteore luminose* Turin, 1883, p. XVI.

Thompson of Hosier Lane, instrument makers of the seventeenth century [1]

The firm of THOMPSON (or TOMSON) in Hosier Lane appears to have been well known in the seventeenth century. In books published about 1610 there are advertisements for JOHN TOMSON; and frequent references to ANTHONY THOMPSON, of Hosier Lane, occur in books published about 1650 or 1660. CLAY and COURT in "The History of the Microscope" (C. GRIFFIN, London, 1932) refer in a list of instrument makers to "THOMPSON, (or TOMSON) ANTHONY, of Hozier Lane, Smithfield" and also to "THOMPSON, Junior. Same address," which implies that the firm was continued after the time of ANTHONY.

Many of the advertisements mention specifically that TOMSON makes his scales in wood, which accounts for the fact that little of his work appears to have survived. There are no examples in the Science Museum.

Below are given some of the references to the firm of THOMPSON (or TOMSON) :

I. In "Baculum geodaeticum sive viaticum or The Geodeticall Staffe" by ARTHUR HOPTON. London, 1610, at page 11 (chapter 6) there is the following sentence in the text :

"The description of the Geodeticall Staffe and the parts thereof, which you may have ready made by M. READE and JOHN TOMSON in Hosier lane, neare Smithfield in London."

II. The following advertisement occurs on a separate page at the end of "Speculum Topographicum or the Topographicalle Glasse" by ARTHUR HOPTON, London, 1611 : "You may have any of the Instruments in this booke made of wood

(1) Answer to Query 57 (*Isis* 24, 432). See also *Isis* 23, 189-90, 1935.

in Hosier lane, neere Smithfield in London, by JOHN TOMSON."

III. In the first edition of "The Compleat Surveyor" by WILLIAM LEYBOURN, London, 1653, there is a full page advertisement facing page 1 which concludes with the sentence "... the Instruments used or mentioned in this Book, or any Mathematicall Instrument whatsoever is exactly made by Mr. ANTHONY THOMPSON in Hosier Lane neere Smithfield, London." (In the fifth edition of this work which was revised and enlarged by SAMUEL CUNN and published in London in 1722 the advertisement is no longer included).

IV. In "Arithmetick, Vulgar, Decimal, and Instrumental" by WILLIAM LEYBOURN, London, 1657 a series of divided lines are engraved in a diagram which can be used to convert money, weights, and measures to their decimal equivalents. The illustration is marked with the engraver's name : "Deliniavit ANTONIUS THOMPSON."

V. In "The Workes of EDMUND GUNTER" 4th ed. London, 1662 there are pictures of both sides of a sector between which occur the words : "These and all other Instruments for the Mathematicall practice are made by WALTER HAYES at the Crosse daggers in Moore feilds next dore to the Popes head Taverne and allso by ANTHONY THOMPSON in Hosier Lane neare Smithfeild."

"The Description and use of the Sector Crosse-staffe and other Instruments" by EDMOND GUNTER, London, 1636 is illustrated by exactly the same diagram of the two sides of a sector but the advertisement for HAYES and THOMPSON does not appear.

To the fourth edition of the Workes of EDMUND GUNTER, mentioned above, SAMUEL FOSTER has added "The Sector altered and other scales added" and an illustration of this altered sector bears the engraver's inscription :

"Delineavit ANTONIUS THOMPSON."

VI. In "Les Voyages de M. DE MONCONYS" Paris, 1695. Vol. ii, page 150 under a diary entry for 21st June 1663 there is to be found : "... j'allai chez un nommé TOMPSON, qui loge à Smithfilds Ogierlen, qui travaille parfaitement aux instruments de Mathématique, & qui a fait la Machine de

M. RENES, pour dessiner tout ce que l'on voit,... J'achétai de lui un compas, & une regle de bois parfaitement bien gravée des lignes, des cordes, tangentes, et autres d'un côté; & de l'autre toutes les divisions du poûce."

(MONCONYS uses a phonetic spelling for foreign proper names; Ogierlen is intended for Hosier lane, and RENES should be WREN).

(Science Museum,
London, S.W.7.)

H. R. CALVERT.
7th August, 1935.

Remarks concerning the history of twentieth century science *

In spite of the fact that my main duty at present is the study of mediaeval science, and especially of fourteenth century science, my work as a teacher of the history of modern science in Harvard University and my responsibilities as editor of *Isis* oblige me to follow as closely as possible the exuberant development of living science, and to connect and integrate that development with our traditions. Thus I cannot help wondering all the time,

" If the growth of science continues at the present rate, will it remain possible for any historian, however deep his scientific preparation, to understand and record further progress? And will the historian of, say, the twenty-first century be able to write the scientific history of our times? How will he manage to do it? '

I have been thinking of those problems with increasing frequency and insistence during the last fifteen years; and have had many occasions of discussing them with various scientists and scholars. Last year (1935), I exchanged a correspondence on the subject with Dr. WALTER SYDNEY ADAMS, director of the Mount Wilson Observatory. Hence when Dr. JOHN C. MERRIAM, President of the Carnegie Institution, who had been thinking in the meanwhile about similar difficulties, asked me in his letter of Jan. 15, 1936 to explain my own views, it was easy enough for me to comply with his wish and to write the following report within a few hours. After having submitted it to President MERRIAM, it occurred to me that the report would interest many other historians of science and philosophers, and that its publication in *Isis* might elicit valuable criticism and useful suggestions. President

* These remarks form the substance of the author's address as retiring Vice-President of the A.A.A.S., and chairman of section L (Historical and philological sciences) at the Atlantic City meeting (Dec. 1636).

MERRIAM being as keenly aware of these advantages as myself, kindly allowed me to publish it.

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Leaving aside technical difficulties and assuming that the historian has no trouble in understanding the scientific achievements of to-day (which is a big assumption), he must still face a very complicated problem : he must *select* a relatively few representative documents from among a large mass of others which must of necessity be neglected, otherwise a clear account becomes impossible. In order to understand this better one must realize that his troubles are essentially different from those of the historian of ancient and mediaeval science. As the vicissitudes of time have already destroyed the great majority of ancient documents, the historian dealing with the distant past is obliged to make the most of the extant ones. He does not choose these, they have been chosen for him by an inexorable fate. On the contrary, the historian of modern science is literally submerged by the mass of documents. Assuming that he had no difficulty in understanding each and every one, it would still be physically impossible for him to consider them all. In this case, the natural selection effected by time must be replaced by an artificial selection. One might make it blindly, as Father Time made his (1), but that would be a desperate procedure, which could not satisfy anybody. Our fundamental problem then is to select as well as possible the main scientific documents and monuments of our time.

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It may be objected that historians of science are as little able as the scientists themselves to appraise correctly contemporary efforts. As the historian well knows, this can be proved, as far as the past is concerned, by the comparison of contemporary appreciation, with later ones. The blindness of contemporaries

(1) Father Time's selection is not completely blind. Important and beautiful things have on the whole a greater survival value than unimportant and ugly ones. Father Time's selection is somewhat rough and careless, but it is effective in the long run. Hence our familiar illusions concerning the past. It is glamorous because the mediocre elements have been gradually sifted out, while the present is often dull and oppressive because all that is good and beautiful is submerged by the flood of mediocrity.

is to some extent unavoidable because the value of a theory or of a discovery is a function of its fruits—some of which may be considerably delayed. However good their knowledge of the past, historians cannot penetrate the future, and hence, however wise their analysis and interpretation of contemporary theories, their conclusions are necessarily incomplete and tentative. We can hardly expect these conclusions to be more mature than the theories themselves.

That objection is specious. If it were allowed to stand, the writing of the history of science would have to be abandoned. Indeed that objection does not affect contemporary events alone. In a sense no scientific theory is ever final; it is always liable to criticism, modification and even repudiation; hence historical judgments are at best tentative. The wisest historian writing toward the end of last century would have appreciated optical theories in a manner which would not be acceptable today. Science is gradually built up by the method of successive approximations; the history of science is necessarily built up in the same way. It can never be considered perfect but it may be indefinitely perfected.

It is not correct to say that the historian cannot appraise contemporary achievements. He can and does appraise them, but his appraisal is necessarily approximative and tentative. It may have to be revised time after time, but in the meanwhile it may do good service.

A selection must be made, and every precaution should be taken to make it as well as possible. In spite of these precautions it is bound to be imperfect in many ways. However, an imperfect selection is better than none, and is itself a means of gradual improvement.

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It is true in a general way that we must be at a certain distance (in space and time) in order to view things in proper perspective, and the bigger they are the greater must be our distance from them if we wish to see them in their wholeness and to appreciate correctly the relationships of the different parts to each other and to the whole. Thus it is certainly easier to appreciate the scientific achievements of the seventeenth century than those

of the nineteenth, and our judgment is likely to be more often correct in the first case than in the second. Moreover our judgment of contemporary personalities is more likely to be vitiated by irrelevant considerations, to be more partial—less objective—than our judgment of men with whom personal contacts have been completely eliminated. The great men of to-day may seem less great to-morrow, and others whom we have despised or overlooked may become more and more important as the centuries go by.

Nevertheless our judgment of our contemporaries will always remain interesting, even if it needs correction or is proved to be completely wrong, for that judgment will help to judge us. Thus in our appreciation of the past we take into account not simply the achievements themselves, but the contemporary criticism of them.

While we realize the great difficulties of our task, and the many chances of errors, we realize with equal strength our responsibilities. For the guidance of the scientists themselves, as well as for the guidance of philosophers and educated men, it is necessary to apply historical methods to the study of living science. We must at least write *chronicles* of it, and thus facilitate the task of later historians.

* * *

Let us consider the preparation of chronicles of the development of science from 1901 to 1940 (inclusive). I write "1940," for if my suggestions were carried out at once, the survey could not be completed within less than five years. The method would consist essentially in compiling a chronological list of the scientific achievements of those forty years, somewhat in the way it was done in LUDWIG DARMSTAEDTER's *Handbuch zur Geschichte der Naturwissenschaften und der Technik* (2nd ed., Berlin, 1908), but with far greater thoroughness and precision.

DARMSTAEDTER's collaborators did only the first part of the work, and even that not too carefully. A similar list of main achievements should be compiled on the following bases : annual surveys of various sciences published in various journals, or in the form of presidential addresses to various societies, or otherwise; annual lists such as those published in the *Monthly notices of*

the Royal Astronomical Society, or in *Science News*, or elsewhere.

A large-sized card would be devoted to each discovery or achievement, and would bear the following indications : date; definition of the achievement; determination of its publication; various remarks clarifying the meaning of the achievement and indicating its relationship (cause, effect, simultaneity, degree of dependence or independence) with other achievements. The date might need qualification too. Indeed when one speaks of the date of a discovery, more than one date may be meant : date of actual discovery, date of communication to a learned body, date printed on the published account, actual date of publication. The names of the scientists should be quoted completely, together with the dates of birth (and eventually of death), but no other biographical information, except details which might throw light on their particular achievement.

The redaction and classification of those cards would constitute the first stage of the work. The second stage would consist in taking out all the cards relative to a special subject, and studying the original memoirs in due sequence. This would make it possible to correct and complete the analytical notes already included in the cards. In addition to this, advantage should be taken of the historical indications which are given in almost every memoir. The author indicates the source of his investigations, or he refers to other investigations of a similar kind, and so on. On the basis of such references new cards would eventually be prepared, or earlier ones corrected and annotated.

With regard to the dead scientists, the general appreciation of their work contained in biographies or obituaries would improve our focussing and frequently would help us to restate the achievements with more clearness and authority.

As to the living scientists, after having taken all these preliminary pains, we would feel justified (2) in writing to them—explaining our general purpose and asking for their personal coöperation.

(2) There has been considerable abuse of questionnaires by lazy authors who exploited that method in order to accumulate easily and rapidly the substance of a book. In this case however our questions would only be a means of obtaining additional information and improve our selection. They would be justified on the one hand by the quantity and earnestness of our own investigations, and on the other hand by the need of eliciting the scientists' own reactions to the achievements of their contemporaries.

They would be asked (1) to define their main achievements adding the necessary bibliographical references and the qualifications suggested by later experience, (2) to indicate other achievements of contemporary scientists to which they attach special importance, (3) to offer any other pertinent suggestions.

These inquiries might be completed by similar ones addressed to other members of the main scientific academies or societies. The critical spirit is very different from the creative one; some people are richly endowed with the former though not with the latter : their coöperation would be very useful.

All the data thus obtained would be reclassified, and it would then be realized that certain achievements are referred to more frequently, and with more emphasis, than others. This would enable us to put a star (or two stars, or more) on certain cards, and thus to begin a preliminary graduation of these achievements. Other cards on the contrary would bear a question mark (or more marks), to indicate that their final inclusion is or is becoming questionable.

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The patent literature might be searched and would probably introduce some items of true scientific interest. Basic patents are likely to contain new scientific ideas. The study of that special literature offers great difficulties of its own, of which I am aware because of long conversations with a great inventor (L. H. BAEKELAND), but I am not sufficiently familiar with them to venture any discussion of them. An officer of the Patent Office or another specialist of patent literature might be invited to give his own views of the subject.

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The final classification and editing of all these cards should be done by a group of first-class scientists—men of broad knowledge and experience, who would obtain the advice of specialists whenever they would be in doubt with regard to technicalities.

The chronological list of achievements—constituting a „chronicle of science" — would finally be published, together with a

summary of all the explanations and abundant cross-references. The publication should be completed with two indices (1) of authors, easy to establish, (2) of topics, very difficult and delicate.

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After the publication, about the year 1945, of those *Chronicles of science from* 1901 *to* 1940, the same staff — who would have obtained in the meanwhile very valuable experience of a new kind — would be utilized for other similar undertakings which I shall now proceed to describe.

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In the first place, they would prepare in a similar way a chronology of science in the nineteenth century. In the second place, they would continue the same kind of survey year by year, and publish the corrected results soon after the completion of each decade. For example, it would be possible to publish about 1952, a new edition of their Chronicles extended to the first half of the century, with cumulative indices. New editions would appear in 1962, 1972, etc. — with new cumulative indices from time to time. Each of these successive editions would also contain addenda and errata relative to the previous ones.

At the time of their publication the Chronicles might be preceded by synthetic accounts which would be tentative sketches of the history of science during the period considered. This would be done or not according to possibilities, the main variables being the personalities engaged in the work. The learned scientists (or scientific historians) in charge of it might easily be so analytically minded, so conscientious or fastidious, and so timid that they would shrink from generalities, or on the contrary, they might be more philosophically minded, and sufficiently adventurous to feel the need of intermittent generalizations — if not every day, at least on Sundays and great holydays !

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Thus far I have not laid sufficient stress upon the biographical investigations, which are nevertheless very important. We cannot understand achievements completely, or at least appreciate

their finer points, their human aspect, without knowledge of, and some familiarity with, the men who were responsible for them. The scholars engaged in the compilation of our Chronicles would thus be obliged to undertake considerable biographical investigations : in some cases sufficient biographies would be available, in other cases, they would have to be provided.

Thus the preparation and edition of biographies of contemporary scientists would be an indispensable accessory and by-product of their activity. It is just as well to recognize the need of biographical information at once, and to organize its satisfaction instead of allowing it to become a hindrance.

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A great waste of time and energy is taking place in that very field. Most academies and scientific societies try to publish biographies or at least obituaries of their members. That tendency is responsible for the futile sidetracking of many scientists — who are not gifted for that sort of thing — and for the production of many poor biographies, in addition to a few good ones, and very few which are excellent. Moreover, most of those biographies being buried in academic publications, remain practically unknown except to the members of the academies concerned.

It is clear that one might expect to obtain better biographies if these were centralized in a single authoritative publication, known all over the Republic of Letters. Many would be prepared by professional biographers (members of our office), well aware of the special difficulties and pitfalls of such work, and accustomed to aim for relatively high standards of accuracy and completeness.

The idea would be to publish within a single volume all the information relative to men of science and learning who died in a single year. The *Scientific Necrology* for the year 1940, let us say, would appear in 1945; as the staff would become more experienced the delay might be gradually reduced from five to three years. It would not be wise to reduce it more, as premature publication would tend to increase the number of addenda, especially with regard to the lesser known men of science whose death may remain unnoticed for a longer while.

Each volume would contain brief „who was who" biographies

of all the men of science and learning known to have died within a given year, plus longer biographies (from fifty to a hundred) with portraits and bibliographies of the most prominent among them.

A good model for this part of the undertaking is furnished by the *Deutsches Biographisches Jahrbuch* published by the union of German academies. The German Jahrbuch deals only with Germans, but it includes men who have distinguished themselves not only in the field of science and learning but in other fields as well. Our Necrology would be restricted to science and learning, but extended to the whole world.

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The two undertaking *Chronicles of modern science and learning* and *Scientific Necrology*, being complementary, it would be expedient to conduct them in the same offices, though some officers would devote themselves more exclusively to the one or to the other.

The expense would not be inconsiderable. Accurate scientific work is always expensive (even if it be cheaper in the long run), and this task could only be accomplished by first-rate men. However, the expense would be restricted to salaries and office needs; the offices would be located in or close to a large library, hence a small number of reference books would suffice; there would be no expenses comparable to those incurred in laboratories or observatories.

The *Chronicles of science and learning* and the *Scientific Necrology*, if they were well done, would soon prove to be very valuable and their need would be felt in every laboratory and reference library. Hence without being unduly optimistic, we may say that they would probably pay for themselves — in whole or in part — after a reasonable interval of time.

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The intellectual value of these two parallel undertakings would be considerable. They would help the historians of science of to-day, and even more so those of the future, to find their way among our innumerable scientific publications, and would make

possible the writing in due course of an adequate history of some of the most praiseworthy achievements of our own times. They would lift up the standard of every kind of historical writing and provide an especially strong stimulus to our studies.

People who have not forgotten the tragic failure of the *International catalogue of scientific literature* (3), and who remember the large amounts of money and energy which were sunk in that ambitous undertaking, may be in a hesitating mood with regard to this one. There is an essential difference between the two. The *International catalogue* was purely analytic; its purpose was to record every scientific publication duly classified in topical order. In the meanwhile the number of items increased by leaps and bounds, not only in a normal way, but also abnormally because of racial, national and linguistic competitions. The *Catalogue*, useful as it was, and however well it was done, could not help the historian and the philosopher, nor even the scientist, very much. It put some order in the chaos, but did nothing to cure or alleviate the main evil : the superabundance of futile and second-rate publications.

Our efforts on the contrary are distinctly synthetic. Our fundamental idea is the need not only of order, but of choice, and the problems which we are trying to solve and which we could solve with a fair degree of approximation, would be largely concerned with selection rather than classification. Of course classification is important enough, but it is easier to accomplish — it may be done if not automatically (far from it), at least with less intellectual effort. The selection is extremely difficult and calls for a good deal of wisdom, ingenuity, integrity and courage. The method which I have outlined would enable good scholars to establish on a sound basis a selection which would be as correct as possible and constantly submitted to revision. Thus we would not only prepare the historical synthesis of to-morrow, but clarify the scientific thought of to-day, and, to some extent, we would even help in guiding it.

Harvard Library, 185. GEORGE SARTON.
January 20, 1936.

(3) SARTON, *The study of the history of science*, p. 59 (Cambridge, Mass. 1936).

Babylonian Mathematics

In recent years especially has it been emphasized that the mathematics used by the Babylonians did not originate with them, but rather with the non-Semitic Sumerians who lived just north of the Persian Gulf and south of the Semitic Akkadians. For at least a thousand years prior to 2500 B. C. the Sumerians were generally predominant in Babylonia but they were absorbed into a larger political group by about 2000 B. C. Notable engineering works by means of which marshes were drained, and the overflow of rivers regulated by canals, went back to Sumerian times, like also their remarkable method of writing in cuneiform script, a considerable part of their religion and law, and their system of mathematics, except possibly for certain details.

This system of mathematics was essentially sexagesimal (1) and while a special symbol for 10 was constantly employed it occupied a subordinate position; there was no symbol for 100 or 1000. One hundred was $1.60 + 40$ and $1000 = 16.60 + 40$, but the latter would be written simply as 16,40. Any positive "integer" $a = \sum c_n 60^n$ would be of the form $a = \ldots c_2, c_1, c_0, c_{-1}, c_{-2} \ldots$, where one or more of the c's may be zero. Thus the system was relatively positional. Ambiguities arose in a variety of ways for example, three symbols for unity following another in cuneiform writing, III, might be 3, or 3.60, or $2.60 + 1$, or $1.60^2 + 2.60$, or $1 \cdot 60^2 + 1\,60 + 1$, or $1 \cdot 60^2 + 0 \cdot 60 + 2$, or yet other forms, each of them multiplied by 60^n where n might be any positive or negative integer. It was not until the time of the Greeks that there was a special sign for zero, and often only the context could suggest when a zero was to be interpolated, if

(1) Surmises as to why 60 was chosen as a base of the number system do not seem to suggest anything more than that 60 is divisible by a large number of integers, which might be especially useful in connection with the use of weights and measures. It is interesting, however, to note that in the equally ancient Egyptian civilization the decimal system was basic, from at least 3500 B. C.

there was doubt as to a blank space at the point in question. These elements of difficulty, combined with lack of knowledge of Babylonian mathematical terminology, were potent for almost a generation in defying the translation, for example, of the mathematical tablets 85194 and 85210, transcribed and published in *Cuneiform Texts from Babylonian Tablets* etc. *in the British Museum* (London, part IX, 1900), usually referred to as CT IX. These tablets dating from about 2000 B. C. are only two out of more than a score in the British Museum.

But while such tablets are of great interest and value, as we shall later see, there are many others, a knowledge of which is highly necessary in order to get a true idea of Babylonian mathematics as scholarship of the present day portrays it. There are 48 tablets in the State Museum at Berlin, 27 at the University of Jena, 66 in the Museum of Antiquities at Istanbul, 35 at Yale University, 6 in the Pierpont Morgan Library Collection, 21 at the University of Pennsylvania, 16 at the Louvre in Paris, 6 at Strasbourg National Library and University, 3 at the Royal Ontario Museum of Archaeology, Toronto, 2 at the Ashmolean Museum, Oxford, 7 at Brussels, and 2 in the Böhl collection at Leyden.

During the latter part of the nineteenth and early twentieth centuries a number of these tablets were discussed by such scholars as HINCKS, LENORMANT, OPPERT, KUGLER, HILPRECHT, LANGDON, PINCHES, SAYCE, THUREAU-DANGIN, UNGNAD, WEIDNER, ZIMMERN, SPELEERS, GENOUILLAC, and GADD. An admirable though brief summary of previous work is given in the second volume of MEISSNER's *Babylonien und Assyrien* (1925). Many other scholars contributed to the knowledge of Sumerian, Akkadian, and Babylonian grammar, literature, metrology, and inscriptions. All this was of importance in laying a foundation for the great advances of the past decade.

It should be borne in mind that tablets which are the basis of our study of Babylonian mathematics and astronomy, do not by any means all date from a period long before the wonderful Greek activity, but from the time of ARCHIMEDES back for two thousand years or more. Up to a decade ago it was known that Babylonian astronomical achievements were very remarkable, leading, it is said, to their discovery of the precession of the

equinoxes about 340 B. C. by KIDINNU who is said to have directed an astronomical school at Sippra on the Euphrates. But accounts of their mathematical attainments were not particularly interesting. That accounts now teem with interest is largely due to a young Austrian OTTO NEUGEBAUER who was born at Innsbruck in 1899 and received his doctorate at Göttingen in 1926 for a thesis with the title, *Die Grundlagen der ägyptischen Buchrechnung* (2). Even then, he had already started the study of cuneiform writing. In 1927 and 1928 he published introductory studies, but by 1929, in the first number of his *Studien*, we find not only a critical study of CARL FRANK's very interesting monograph on Strasbourg tablets, which had appeared in the previous year (3) but also a joint article with STRUVE, " Über die Geometrie des Kreises in Babylonien," both containing extraordinary new results. Further articles followed (4), setting forth new disco-

(2) In the following year he became a Docent, and was put in charge of the library of the Mathematical Institute, where in organization and development he did remarkable work during the next six years. In 1931 he became chief editor of a new periodical *Zentralblatt für Mathematik* of which 13 vols. already published have been of great service to mathematicians; so also for *Zentralblatt für Mechanik* (vol. 1, 1934 +) in which he is joint editor with W. FLÜGGE. In 1932 he organized the excellent series *Ergibnisse der Mathematik und ihrer Grenzgebiete*, as an enterprise associated with the *Zentralblatt für Mathematik* and 16 volumes have been published already. In 1929 he started the publication of *Quellen und Studien zur Geschichte der Mathematik* in the form of two serials, *Abteilung A : Quellen* and *Abteilung B : Studien*. Of the latter, two volumes and the first three parts of a third have appeared (1929-36), and contain much of value for our present inquiry. Of the three complete volumes of *Quellen* (1930-35) the third in two parts is the great work of Dr. NEUGEBAUER which in this paper we later consider in some detail.

(3) C. FRANK, *Strassburger Keilschrifttexte in sumerischer und babylonischer Sprache* (Schriften der Strassburger Wissenschaftlichen Gesellschaft in Heidelberg, n. s., part 9).

(4) A few of these may be indicated, as follows :

(i) "Über vorgriechische Mathematik", *(Hamburg mathem. Einzelschriften*, part 8), 1929, 18 p.; also Hamburg Univ., Mathem. Seminar, *Abhandlungen*, v. 7.

(ii) " Sexagesimalsystem und babylonische Bruchrechnung," I-IV, *Studien*, v. 1, 1930-31, p. 183-193, 452-463; v. 2, 1923, p. 199-210.

(iii) " Beiträge zur Geschichte der babylonischen Arithmetik," *Studien*, v. 1, 1930, p. 120-130.

(iv) " Studien zur Geschichte der antiken Algebra I," *Studien*, v. 2, 1932, p. 1-27.

(v) " Reihen in der babylonischen Mathematik " (with WASCHOW), *Studien*, v. 2, 1932, p. 298-304.

(vi) " Bemerkungen über Quadratwurzeln und Quadratwurzelapproximationen

veries which could only have been suggested to a Babylonian scholar who also had wide mathematical knowledge and training. Many of these results were embodied in a course of lectures given at the University of Copenhagen. The first published volume of these lectures appeared in 1934 with the title *Vorlesungen über Geschichte der antiken mathematischen Wissenschaften. Erster Band, Vorgriechische Mathematik.* But this volume was only a prelude to the third volume of his *Quellen*, published last year. This work is entitled *Mathematische Keilschrift-Texte* and the first part is a royal octavo volume of 528 pages. It is almost wholly made up of transcriptions and translations of tablets and of detailed commentary. There are seven chapters, the first dealing with table texts, and the six following with texts, in the Louvre, in the British Museum, in Istanbul, in Strasbourg, in the Berlin Museum, and in Yale University.

The large quarto second part contains material supplementary to the first part; a concordance giving the number and location of all the mathematical tablets; glossaries of Akkadian words, of ideograms and Summerian words, and names; a bibliography; 60 plates, the first 34 of which are most beautiful photographic reproductions of texts, while the rest are mostly transcriptions of these and other tablet documents. Thus, in article, *Vorlesungen*, and *Quellen* 3, we find Neugebauer frequently discussing the same thing in three different ways. This is often of great assistance to the amateur trying to get a clear idea of the contents of tablets

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in der babylonischen Mathematik" (with H. WASCHOW), *Studien*, v. 2, 1932, p. 291-297.

(vii) "Das Pyramidenstumf-Volumen in der vorgriechischen Mathematik," *Studien*, v. 2, 1933, p. 347-351.

(viii) "Über die Lösung kubischer Gleichungen in Babylonien," Gesellschaft d. Wissen. zu Göttingen, *mathem.-phys. Kl., Nachrichten*, 1933, p. 316-321.

(ix) "Über die Rolle der Tabellentexte in der babylonischen Mathematik," K. Danske Vidanskabernes Selskab, *mathematiksfysiske Meddelelser*, v. 12, no. 13, 1934, 14 p.

(x) "Serientexte in der babylonischen Mathematik," *Studien*, v. 3, 1934, p. 106-114.

The student interested in Babylonian mathematical literature before 1929 may refer to my Bibliography in the CHACE-BULL-MANNING-ARCHIBALD work on *The Rhind Mathematical Papyrus* (Math. Assoc. America, 1927-29). A very useful later Bibliography was published by Dr. KURT VOGEL, in his "Babylonische Mathematik," *Bayer. Blätter f. d. Gymnasialschulwesen*, v. 71, 1935, p. 16-23. This latter list shows the impetus that NEUGEBAUER's work has given to the subject.

discussed, because NEUGEBAUER's powers of lucid and effective exposition are by no means comparable to his other extraordinary gifts.

So much for sources to which one may turn for surveying investigations in the field of Babylonian mathematics. Let us now once more take up the question of indicating the nature of the mathematics known and employed.

Again and again has NEUGEBAUER emphasized the fundamental rôle which tables play in the mathematics of the Babylonians, and the fact that discussion of them occupies nearly 100 pages of his last remarkable work bears witness to this fact. Ordinary multiplication tables are very numerous and are almost always the products of a certain number by 1, 2, 3, ..., 20, then by 30, 40, and 50. For example on tablets of about 1500 B. C. at Brussels (5) are tables of 7, 10, 12½, 16, 24 each multiplied by a series of such numbers. A number of tablets give the squares of numbers (6) 1 to 50, and also the cubes, square-roots and cube-roots of numbers. But the tables of square-roots and cube-roots are really just tables of squares and cubes expressed differently (7). As an example of an arithmetical operation in the

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(5) L. SPELEERS, *Recueil des Inscriptions de l'Asie Antérieure des Musées Royaux du Cinquantenaire à Bruxelles*, Brussels, 1925, p. 29, 94-95. In the University of Pennsylvania there are twenty-three tablets containing multiplication tables, in part or complete, and dated for the most part about 1300 B. C.; but a few are dated 2000 B. C. The multipliers are such numbers as : 2, 6, 9, 18, 30, 36, 90, 432, 450, 540, 960, 1080, 2160; see H. V. HILPRECHT, *Mathematical, Metrological and Chronological Tablets*, Philadelphia, 1906, p. 57-61, 68-69. See also British Museum, *A Guide to the Babylonian and Assyrian Antiquities*, third ed., London, Philadelphia, 1906, p. 69, and plate X. See also British Museum, *A Guide to the Babylonian and Assyrian Antiquities*, third ed., London, 1922, p. 161. For references to others, see *Quellen* 3, part 1, p. 10-12.

(6) For example, in the University of Pennsylvania, dating from about 1300 B. C,; see HILPRECHT, *Mathematical, Metrological and Chronological Tablets*, Philadelphia, 1906, p. 69, and plate X, See also British Museum, *A Guide to the Babylonian and Assyrian Antiquities*, third ed., London, 1922, p. 161, and GENOUILLAC, *Premières Recherches Archéologiques à Kich*, v. 1-2, 1924-25, and *Quellen* 3, part 1, p. 69-71.

(7) The two tablets with square roots in the University of Pennsylvania date from about 2000 B. C.; see HILPRECHT, *ibid.*, p. 62-63, and pl. 16. A tablet in the British Museum dating from about 1900 B. C. and containing tables of square roots and cube roots is described in F. LENORMANT, *Essai sur un Document mathématique chaldéen*, Paris, 1868 (for further references in this connection see my Bibliography). For a tablet with squares, cubes, etc., of a given number see

course of a problem of about 2000 B. C. we may note a passage from a tablet discussed in the monograph of FRANK (p. 21) already referred to : "... the square of 13, 20 is 2, 57, 46, 40. Add 2, 57, 46, 40 to 50, 33, 30. It is 53, 31, 6, 40. The square root of 53, 31, 6, 40 is 56, 40." The last two numbers in this quotation are respectively said to be four-place and two-place numbers. The only known table of squares of two-place numbers is on a tablet in the Ashmolean Museum at Oxford (8); it dates from about 500 B. C. It is noteworthy in another respect, namely that in the case of four numbers there is a sign for zero. For example $(24, 30)^2 = 10, ., 15$, that is $(1470)^2 = 2160900$.

There is a single tablet of a very interesting type in the Berlin Museum (VAT 8492) where for $n = 1, 2, \ldots 20, 30, 40, 50$ we have (9) not only n^2 and n^3, but also $n^2 + n^3$. At first NEUGEBAUER could see no application for such a table, or even for the tables of cubes, but finally, he surmised that they were to be used in solving cubic equations which had been reduced to a " normal form." In British Museum tablets of about 1800 B.C., reproduced in *C. T.* IX, are six problems which seem naturally to lead to one-term, three-term, and four-term cubic equations, but the solution of only three of these fits in with his theory. The two-term case leads simply to finding the cube-root of a number, and two of the three-term cases lead to

$$(\mu x)^3 + (\mu x)^2 = 4, 12;$$

from the Berlin tablet the solution $\mu x = 6$ may be found immediately. Two of the problems seem to lead naturally to the equation

$$x^3 - (1 - \mu b)x^2 - bx + a = 0$$

and this is not reduced to the normal form. But on the contrary the text gives (in the case of the second of the problems)

British Museum, *A Guide to the Babylonian...*, 1922, p. 161. See also M. CANTOR, " Babylonische Quadratwurzeln und Kubikwurzeln," *Zeitschrift für Assyriologie*, v. 21, 1900, p. 110-115. For a number of other references to tablets in Berlin, Istanbul, etc. see *Quellen* 3, part 1, p. 68-75.

(8) *Quellen* 3, part 1, p. 72-73, and part 2, plate 34.

(9) *Studien*, v. 2, 1932, p. 303-304; Göttingen, *Nachrichten*, 1933 (see above), p. 320; *Quellen* 3, part 1, p. 76-77; *Vorlesungen*, p. 32-33, 195, 199-200.

$$\frac{\mu x^2 y + xy}{\mu b^3} = \frac{x}{b} \cdot \frac{y}{b} \cdot \frac{z+1}{\mu b} = 21,$$

whence it is inferred that $x/b = 3$, $y/b = 2$ and $(z + 1)/\mu b = 3, 30$. NEUGEBAUER contends that the Babylonians were quite capable of using a linear transformation $z = x + c$ to reduce the general four-term cubic equation $x^3 + a_1x^2 + a_2x + a_3 = 0$ to the form $u^3 + b_1u^2 + b_2 = 0$. And also by multiplying this equation $1/b_1^3$ and setting $u = b_1w$, and $a = -b_2/b_1^3$, of arriving at the equation in the normal form $w^3 + w^2 = a$. But any case of the solution of the general cubic equation in this way has yet to be found.

There is a large group of tables to which NEUGEBAUER pays a great deal of attention, namely the tables of reciprocals. He uses the convenient notation $1/n = \bar{n}$, so that in a Babylonian table of reciprocals we would find $n.\bar{n} = 60^p$, where p is equal to zero, or some positive or negative integer. The tables usually consists of two columns of numbers such as

4	15
5	12
6	10
8	7, 30
9	6, 40
10	6
27	2, 13, 20
1, 21	44, 26, 40

where the products of pairs of numbers on the same line may always be considered as 60. If such numbers as 7 or 11 occur in the first column the remark is made " does not divide "; these are the irregular numbers. The regular divisors must be of the form $a = 2^\alpha \cdot 3^\beta \cdot 5^\gamma$ (where α, β, γ are each either zero, or a positive integer) if the corresponding number is to have a finite number of terms in the second column. By means of a table of reciprocals division is changed into multiplication $b/a = b \cdot \bar{a}$.

From the above it may be correctly surmised that the Babylonians either never attempted to divide anything by 7 (or other number not of the form a, above) or else arranged the problem in which such a divisor might occur so that the divisor would

disappear before the final result was reached. Since such approximations to 1/7 as 7/48 = ;8,45, and 13/90 = ;8,40, are readily written down it might be thought that the Babylonian may have used them; but Dr. NEUGEBAUER has kindly informed me that he never met with such a case, though he himself has used the first of these approximations in one of his discussions.

To give a suggestion of the extraordinary extent of some tables of reciprocals, particular attention may be drawn to tablet AO 6456, of about 350 B. C., in the Louvre (10), on which there are 252 entries of one-place to seventeen-place divisors, and one-place to fourteen place reciprocals. Two examples may be cited

2, 39, 25, 56, 16, 48 22, 34, 48, 25, 17, 19, 46, 49, 52, 35, 33, 20
2, 59, 21, 40, 48, 54 20, 4, 16, 22, 28, 44, 14, 57, 40, 4, 56, 17, 46, 40

In each case $n.\bar{n}$ may be thought of as 60^{19}.

We have seen how tables of cubes of numbers may have applications, but similar consideration of tables of powers is fully as interesting; such tables are found in Istanbul tablets (11) (Ist. O 3816, 3826, 3862, 4583). In his *Vorlesungen* (p. 201) NEUGEBAUER stated definitely that we have tables for c^n from $n = 1$ to 10 for $c = 9$, $c = 16$, $c = 1{,}40$, $c = 3.45$. This is highly misleading, since, with the badly mutilated text now before us, we see that not more than 6 out of the 40 stated entries are given completely and correctly, while many are entirely lacking, and others very fragmentary.

One use for such tables is in connection with problems of compound interest. In Babylonia the paying of interest for the loan of produce or of precious metal was common. Sumerian tablets indicate that the rate of interest varied from 20 to 30 percent, the higher rate being for produce. At a later period the rate was $5\frac{1}{2}$ to 25 percent for metal and 20 to $33\frac{1}{3}$ percent for produce (12). In a Louvre tablet (AO 6770) of about 2000

(10) *Quellen* 3, part 1, p. 14-22.

(11) *Quellen* 3, part 1, p. 77-79.

(12) M. JASTROW, Jr., *The Civilization of Babylonia and Assyria*, Philadelphia, 1915, p. 326, 338; C. H. W. JOHNS, *Babylonian and Assyrian Laws, Contracts and Letters*, New York, 1904, p. 251, 255-256. See also D. E. SMITH, *History of Mathematics*, Boston, v. 2, 1925, p. 560.

B. C. there is a problem (13) to find how long it would take for a sum of money to double itself at compound interest, interest being computed at 20 %. The problem, then, is to find x in the equation

$$(1 + 0;12)^x = 2.$$

The correct result is approximately 3;48 years; but the text gives $x = 4 - 0;2, 23, 20 = 3;57, 26, 40$ years. It would seem as if a table of powers may have been used to find

$$1;12^4 = 2;4, 24, 57, 36$$

which was too large. How the amount to subtract from 4 namely, 0;2, 23, 20, was determined, is not indicated in the text, and has not yet been conjectured. The example is especially interesting as illustrating that four thousand years ago solutions were found of exponential equations $a^x = b$, where x was not integral.

A Yale tablet (YBC 4669) leads (14) to an annual interest formula, $b = a(1 + z)^n$, but here $n = 3$, while $z = 0;12$, $b = 1$, and $a = 0; 34, 43, 20$.

Two Berlin tablets (15) (VAT 8521 and 8528) dating from about 2000 B. C. consider problems involving a five-year plan, with a combination of simple and compound interest, suggestive of what may have been customary in ancient Babylonia. If P is an amount of principal, r the rate of interest for year (here 20 %), $2P$ will be the amount at simple interest at the end of five years. If this $2P$ is then considered as principal $4P$ will be the amount at the end of a second five-year period. Thus the amount at the end of any year is given by the formula

$$A = 2^n P(1 + rm)$$

where $0 \leqslant m < 5$, and n is the number of five-year periods. The particular case when $m = 0$ is considered, namely $A = 2^n P$, and one problem is, how many five year periods would it take for a sum P to amount to A. The solution of the problem in question is very simple, namely $P = 1$, $n = 6$, $A = 1, 4$. But

(13) *Quellen* 3, part 2, p. 40-41.
(14) *Quellen* 3, part 1, p. 516.
(15) *Quellen* 3, part 1, p. 351-367; *Vorlesungen*, p. 197-199.

NEUGEBAUER believes that the text discussion implies a good deal more, even possibly the knowledge of something like the equivalent of logarithms to the base 2, since $n = \log_2(A/P)$.

There are problems of another type involving the power of numbers on a Louvre tablet (16) (AO 6484) of about 300 B. C. One problem the geometric series of ten terms with 1 as the first term and 2 the constant multiplier is summed correctly,

$$\sum_{i=0}^{9} 2^i = 17{,}3 = 1023.$$

But this 17,3 is said to be equal to the sum of 8,31 (= 8,32 — 1) and 8,32, that is, of $2^9 + 2^9 - 1$, or $2^{10} - 1$. Does this imply a knowledge of EUCLID's formula for the sum of ten terms in the geometric progression leading to $(2^{10} - 1)/(2 - 1)$?

On the same tablet the sum of the squares of the first ten integers is given as in the right-hand member of

$$\sum_{i=1}^{10} i^2 = (1 \cdot 1/3 + 10 \cdot 2/3)55.$$

Now if this be generalized we get

$$\sum_{i=1}^{n} i^2 = (1 \cdot 1/3 + n \cdot 2/3) \sum_{i=1}^{n} i.$$

Was this formula known to the Babylonians? Since

$$\sum_{i=1}^{n} i = (1/2)n\,(n + 1)$$

was derived by the Pythagoreans, we have

$$\sum_{i=1}^{n} i^2 = \frac{1}{6} n\,(n + 1)\,(2n + 1),$$

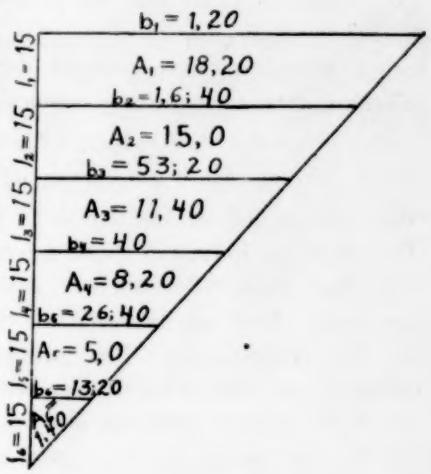
which is practically equivalent to a result in work of Archimedes. We are of course here referring to a tablet not very far removed from the time of ARCHIMEDES.

In a Strasbourg tablet (no. 362), dating from about 2000 B. C. we find four terms of another geometric series (17) of which the first term is 1;2, and the constant multiplier is 2. The numbers of workers on sections of an embankment, discussed in the same tablet, are in arithmetic progression, namely, 60, 80, 100.

In another Strasbourg tablet (no. 364) there are three pro-

(16) *Quellen* 3, part 1, p. 96-103, and part 2, plate 1; *Studien*, v. 2, 1932, p. 302-303.
(17) *Quellen* 3, part 1, p. 243.

blems (18) which involve the division of a right triangle into six areas by lines drawn parallel to one side (as in the figure). These areas are in arithmetical progression, the first term being $A_6 = 1{,}40$, the common difference being 3,20 and the last term $A_1 = 18{,}20$. In the first problem $b_4 = 40$, $A_1 = 18{,}20$, $A_2 = 15{,}0$, $b_1 - b_2 = b_2 - b_3 = 13;20$ are given; the problem is to find l_1, l_2, l_3, b_1, b_2, and b_3. Now we could at once write down



$$\tfrac{1}{2}\, l_1(b_1 + b_2) = 18{,}20$$

$$\tfrac{1}{2}\, l_2(b_2 + b_3) = 15{,}0$$

and from proportion

$$l_1 = l_2, \quad \frac{13;20}{l_2} = \frac{b_3 - 40}{l_3};$$

whence, the six unknowns can be determined from the six equations. In writing down these equations the following results familiar to the Babylonians were used: (a) The sides about corresponding angles of two similar right triangles are proportional; (b) The area of a trapezoid with one side perpendicular to the parallel sides is one-half the product of the length of this perpendicular and the sum of the lengths of the parallel sides. They knew also, (c), that the area of a rectangle is the product of the lengths of two adjacents sides; and that the area of a right triangle is equal to one-half the product of the lengths of the sides about the right angle.

In the second problem of this figure $b_4 = 40$, $l_4 + l_5 = 30$, $A_1 = 18{,}20$, $A_2 = 15.\ 0$, $A_6 = 1{,}40$ and the eight unknowns, b_1, b_2, b_3, b_6, l_1, l_2, l_3, l_6 are to be determined. These can be found at once from the relations $\tfrac{1}{2}\, l_1(b_1 + b_2) = 18,\ 20$, $\tfrac{1}{2}\, l_2(b_2 + b_3) = 15,\ 0$, $\tfrac{1}{2}\, l_6 b_6 = 1,\ 40$, and

$$\frac{b_1 - b_2}{l_1} = \frac{b_2 - b_3}{l_2} = \frac{b_3 - 40}{l_3} = \frac{40 - b_1}{30} = \frac{b_6}{l_6}.$$

(18) *Quellen* 3, part 1, p. 248-249, 252-254; *Studien*, v. 1, 1929, p. 74-77; *Vorlesungen*, p. 180-181.

In the third problem $A_1 = \frac{1}{2}\, l_1(b_1 + b_2) = 18, 20$, $A_2 = \frac{1}{2}\, l_2(b_2 + b_3) = 15, 0$, $A_4 + A_5 = \frac{1}{2}(l_4 + l_5)\cdot(b_4 + b_6) = 13, 20$, $b_1 - b_2 = b_2 - b_3 = 13; 20$, $\frac{1}{2}(b_2 - b_2) = 13;20$ and the following 10 unknowns are sought $b_1, b_2, b_3, b_4, b_6, l_1, l_2, l_3, l_4, + l_5, l_6$. They may be readily found when we have written down the following additional relations from geometrical considerations :

$$\frac{b_1 - b_2}{l_1} = \frac{b_2 - b_3}{l_2} = \frac{b_3 - b_4}{l_3} = \frac{b_4 - b_6}{l_4 + l_5} = \frac{b_6}{l_6}.$$

Thus there are 10 equations to determine the 10 unknowns. The solutions indicated above are not actually to be found in the text; but, from a number of other problems, where solutions are given, there can be little doubt as to the method employed by the Babylonians. The problem is further suggestive of mathematics studied for its own sake just as the following problem 40 of the Rhind papyrus also using arithmetical progression : Divide 100 loaves among 5 men in such a way that the shares received shall be in arithmetical progression and that 1/7 of the sum of the largest three shall be equal to the sum of the smallest two. Another problem on a Strassburg tablet (no. 362) is to divide 100 shekles of silver among ten brothers so that the shares shall be in arithmetical progression (19).

Yet another Strasbourg tablet (no. 363) has problems leading to quadratic equations and their solution. One of these problems is as follows : The sums of the areas of two squares (the lengths of whose sides are x and y) is equal to a given quantity $A(= 37, 5)$. The side x of the larger square is equal to a certain quantity $u + d_1(= 10)$ and the side y of the smaller is equal to

$$\frac{a}{\beta} u(= 2/3\, u) + d_2\ (= 5).$$

That is

$$x^2 + y^2 = A, \quad x = u + d_1 \quad y = \frac{a}{\beta}\, u + d_2,$$

whence, if $W\beta = u$,

$$W^2 + \frac{2(d_1\beta + d_2 a)}{a^2 + \beta^2}\, W - \frac{A - (d_1^2 + d_2^2)}{a^2 + \beta^2} = 0$$

or

(19) *Quellen* 3, p. 239-242; *Studien*, v. 1, 1930, p. 120-123; *Vorlesungen*, p. 174-175.

$$W = \frac{1}{\alpha^2+\beta^2}\left\{\sqrt{(d_1\beta+d_2\alpha)^2+(\alpha^2+\beta^2)[A-(d_1^2+d_2^2)]}-(d_1\beta+d_2\alpha)\right\}.$$

Now every single step of the solution on the tablet is equivalent to substitution in this formula. There are scores of problems which prove this amazing fact that the Babylonians of 2000 B. C. were familiar with the equivalent of our formula for the solution of a quadratic equation. Until 1929 no one suspected that such a result was known before the time of HERON OF ALEXANDRIA two thousand years later.

In a Berlin tablet (VAT 8520) we have a quadratic equation for reciprocal numbers (20)

$$(1)\qquad y_1-\frac{\alpha}{\beta}(y_1+y_2)=D,\quad y_1\cdot y_2=1,$$

where $\alpha = 6$, $\beta = 13$, $D = 0;30$.

The first step in the solution is to make a transformation

$$(2)\qquad \begin{cases} x_1 = (\beta-\alpha)y_1, \\ x_2 = \alpha y_2, \end{cases}$$

from which $x_1 - x_2 = \beta D$, and $x_1x_2 = \alpha(\beta-\alpha)$. Hence x_1 and $-x_2$ are roots of the equation

$$w^2 - \beta D w - \alpha(\beta-\alpha) = 0$$

$$(3)\qquad \left.\begin{matrix} x_1 \\ x_2 \end{matrix}\right\} = \pm\frac{\beta D}{2}+\sqrt{\left(\frac{\beta D}{2}\right)^2+\alpha(\beta-\alpha)}.$$

The text leads exactly to equations (3) from which $x_1 = 10;30$ and $x_2 = 4$. Then y_1 and y_2 are found from equations (2) $y_1 = 1;30$, $y_2 = 0;40$, and they are tested by substitution in equations (1). NEUGEBAUER emphasises that here, as in other texts, we have a transformation to a " normal form " in which the coefficient of the squared term in the quadratic equation is unity. The use of both positive roots of the quadratic equation is also noteworthy; a number of other examples of this kind might be cited, in accordance with NEUGEBAUER's interpretation.

It is, however, important that the reader should consult Dr. KURT VOGEL's " Bemerkungen zu den quadratischen Gleichungen der

(20) *Quellen* 3, part 1, p. 350-351; *Vorlesungen*, p. 186-187.

babylonischen Mathematik" (*Osiris*, v. I, 1936, p. 707-717), since other possible Babylonian discussion of quadratic equations is here clearly presented, and quite different from that of NEUGEBAUER, while entirely in keeping with all texts published before *Quellen* 3, at least. According to this discussion also there is no question as to two roots of a quadratic equation, but always a perfectly definite one, even when both roots are positive.

The continuation of our examples of problems which are pure algebra naturally leads us to the series and other texts at Yale University (21). They contain nothing but the statement of problems with no suggestion as to the method of their solution. On 17 tablets are over 900 problems, from 17 on YBC 4698 (8 × 5 cm.) to about 200 on YBC 4668 (16½ × 10 cm.). There are problems on the calculation of volumes, of material for workers, and of interest, but most of the problems involve various types of equations; zero, and negative numbers in right hand members of equations, occur several times. By series-texts is meant texts in which all the exercises are of a given type. For example on YBC 4709 are found 55 pairs of simultaneous equations, included in the following general form:

$$xy = 10, 0 \text{ and } (ax + by)^2 + cx^2 + dy^2 = B,$$

the solution of each of which leads to a biquadratic equation which is quadratic in x^2. Since $xy = 10, 0$ for all the examples, problems 49-52 are

$$\begin{aligned} [3x + 5y - 2(x - y)]^2 + x^2 + y^2 &= 8, 23, 20 \\ + 2(x^2 + y^2) &= 8, 45, 0 \\ - (x^2 + y^2) &= 7, 40, 0 \\ - 2(x^2 + y^2) &= 7, 18, 20 \end{aligned}$$

In YBC 4668 the problems are of the type $xy = 10, 0$ and $a(x + y)^2 + b(x - y) + c = 0$ the solution of which leads to general biquadratic equations. Examples 42 and 45 here are

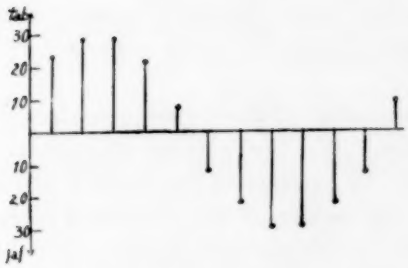
$$\begin{aligned} 2, 30(x - y) - (x + y)^2 &= -16, 40 \\ \tfrac{1}{2}(x + y)^2 - 1, 0(x - y) &= -1, 40 \end{aligned}$$

These negative terms in the right hand members are certainly

(21) *Quellen* 3, part 1, p. 381-516, and part 2, p. 50, plates 33, 34, 57-60; *Vorlesungen*, p. 188-193; *Studien*, v. 3, 1934, p. 106-114.

most extraordinary, because such conceptions were not current in Europe even 2500 years later. In this connection one may recall the extract from a text which NEUGEBAUER gives (22) (the words *tab* and *lal* correspond to + and —; 37 = 40 *lal* 3) :

26, 21	*tab*
31, 23, 30	*tab*
31, 47, 30	*tab*
23, 15	*tab*
7, 55	*tab*
11, 57, 30	*lal*
25, 2, 30	*lal*
31, 20	*lal*
31, 50	*lal*
25, 48, 30	*lal*
11, 43, 30	*lal*
9, 9	*tab*



Now if the corresponding points be plotted (as in the figure) they lie on a wave line exhibiting periodic observations, which are to be a topic for discussion in NEUGEBAUER's third volume of *Vorlesungen*. The idea here suggested seems very extraordinary.

Returning to our series-texts we note that an equation of the sixth degree (or a quadratic in x^3) results from the solutions of equations of the type $xy = 10,\ 0,\ a_1(x^2/y) + a^2(y^2/x) + a^3 = 0$ (YBC 4668) (23). The general cubic equation comes up in the discussion of volumes of frustums of a pyramid, as the result

(22) *Vorlesungen*, p. 18.
(23) *Quellen* 3, part 1, p. 460.

of eliminating x and z from the equations $z(x^2 + y^2) = A$, $z = (ay + b)$, $x = c$ (YBC 4708) (24). Another example in a Berlin tablet (VAT 7537) is interesting because of the irregular fractions occuring in the coefficients (25): $xy = 10, 0$ and

$$x^2 + \frac{1}{13}\left\{\frac{1}{19}[(x + y)^2 - 10, 0] + 3y^2\right\} = 16, 40.$$

And finally, as an example of four equations in four unknowns (YBC 4714) (26):

$$\sum_1^4 x_i^2 = 52, 30, \frac{1}{7}x_1 = x_1 - x_2 = x_2 - x_3 = x_3 - x_4.$$

NEUGEBAUER has pointed out the intimate connection of the Yale series-texts with texts in the Berlin Museum and British Museum. The original group of series-texts must have contained thousands of problems. The fact that examples cited above, and hundreds of other problems involving two unknowns, always have the same solutions, 30 and 20 does not affect NEUGEBAUER's conviction, that they were intended as illustrations of types of problems, to the solution of which general methods were to be applied.

Let us now consider certain other geometrical results known to the Babylonians: (a) The volume of a rectangular paralellopiped is equal to the product of the lengths of its three adjacent edges, and the volume cut off by drawing a plane through a pair of opposite edges is half of this amount. (b) The volume of a right circular cone is equal to the product of the area of its base by its altitude. (c) The volume of the frustum of a cone, or of a square pyramid, is equal to the product of its altitude and the area of a medial section (27). But the Babylonians had also an accurate formula for the volume of the frustum of a square pyramid, namely (28) $V = h\left[\left(\frac{a_1 + a_2}{2}\right)^2 + \frac{1}{3}\left(\frac{a_1 - a_2}{2}\right)^2\right]$ where a_1 and a_2 are the lengths of the sides of the square bases. This is exactly

(24) *Quellen* 3, part 1, p. 399-400.

(25) *Vorlesungen*, p. 193; *Quellen* 3, part 1, p. 475.

(26) *Quellen* 3, part 1, p. 500.

(27) *Quellen* 3, part 1, p. 176; *Studien*, v. 1, 1929, p. 86-87; *Vorlesungen*, p. 171.

(28) *Quellen* 3, part 1, p. 150, 162, 187-188; *Vorlesungen*, p. 171; *Studien*, v. 1, 1929, p. 86-87.

equivalent to the formula $V = (h/3)(a_1^2 + a_1a_2 + a_2^2)$, known to the Egyptian of 1850 B. C. But it is the Babylonian form which was known to HERON OF ALEXANDRIA (*Opera*, v. 5, 1914, p. 30-35), in the early part of the Christian era.

As to a circle the Babylonians of 2000 B. C. knew that the angle in a semicircle was a right angle, a result until recently attributed to THALES OF MILETUS. They considered $\pi = 3$, and the area of a circle equal to one-twelfth of the square of the length of its circumference. It is not a little curious that a people who did such remarkable things in algebra should have used a value of π so much poorer than that of the Egyptian, namely 256/81. On the other hand, while there is not a single document to show that the Egyptian knew even the simplest case of the so-called Pythagorean theorem (29), there is not the slightest doubt that the Babylonian knew the general result. This may be illustrated by various examples. In a British Museum text of 2000 B. C. (B. M. 85194) the following problems are solved (30): (a) To calculate the length c of a chord of a circle from its *sagitta*, a, and the length of its circumference (let d, the diameter = one third of the circumference); (b) To calculate the length of the *sagitta* from the chord of a circle and its circumference. Now every step of the work in the tablet (where $c = 12$, $d = 20$, $a = 2$) is equivalent to substitution in the formulae:

$$c = \sqrt{[d^2 - (d - 2a)^2]} \quad \text{and}$$

$$a = \tfrac{1}{2}[d - \sqrt{d^2 - c^2}].$$

But again in another British Museum tablet (BM 85196) is a problem (31) of a beam of length l originally upright against a wall but the upper end has slid down the distance h; the distance d that the lower end has moved from the wall is determined from

(29) Perhaps a similar assertion may be made with regard to the Babylonians, namely that there is not a single text where it is found that they divided the circumference of a circle into 360 equal parts, which has been current from the time of Hipparchus. The Babylonian division of the circumference into 8, 12, 120, 240, and 480 parts, is known. See my discussion of this question in *Science*, n. s., v. 71, 31 Jan. 1930, p. 117-118; and v. 73, 16 Jan. 1931, p. 68.

(30) *Quellen* 3, part 1, p. 159, 180; *Studien*, v. 1, 1929, p. 90-92; *Vorlesungen*, p. 168.

(31) *Quellen* 3, part 2, p. 53.

the formula $d = \sqrt{l^2 - (l - h)^2}$. In another problem when l and d are know h is found from $h = l - \sqrt{l^2 - d^2}$. A third illustration is found in a Louvre tablet (32) (AO 6484).

In all of these cases the square roots of the numbers considered are always exact. But there are cases of square roots of non-square numbers such as 1700. This occurs in an Akkadian tablet of about 2000 B. C. where it is a question of determining the diagonal (33) of a rectangle whose sides are of length ;40 and ;10. It is worked out twice seemingly by two approximation formulae. If d be the length of the diagonal and a and b the length of the sides, then, approximately,

$$\text{(i)} \quad d = a + \frac{b^2}{2a}; \text{ and}$$

$$\text{(ii)} \quad d = a + 2ab^2.$$

Now (i) is the formula used, more than once, by HERON OF ALEXANDRIA two thousand years later (34) in approximating the square root of a number. In(ii) the dimensions of the second term of the right hand member are incorrect; NEUGEBAUER found that a good approximation was

$$d = a + \frac{2ab^2}{2a^2 + b^2};$$

and since in the problem in question $1/(2a^2 + b^2)$ is $12/11 \approx 1$, he suggested that this factor may well have been neglected.

The first approximation was used by the Babylonians to find (35) $1\frac{5}{12}$ for $\sqrt{2}$, and 17/24 for $1/\sqrt{2}$. In BM 85194 there is a very suggestive attempt to approximate $\sqrt{2\frac{1}{2}}$ by a step equivalent to that of seeking the solutions of the Diophantine equation (36)

(32) *Quellen* 3, part 1, p. 104; *Studien*, v. 2, 1932, p. 294.

(33) *Quellen* 3, part 1, p. 279-280, 282, 286-287, and part 2, plates 17, 44; *Vorlesungen*, p. 33-36; *Studien*, v. 2, 1932, p. 291-294.

(34) It may be expressed differently; if $A = a^2 + c$ then we have as the first approximation to $\sqrt{A}$, $\alpha_1 = \frac{1}{2}\left(a + \frac{A}{a}\right)$; for a second approximation $\alpha_2 = \frac{1}{2}\left(\alpha_1 + \frac{A}{\alpha_1}\right)$; and so on.

(35) *Quellen* 3, part 1, p. 100, 104; *Vorlesungen*, p. 37; *Studien*, v. 2, 1932, p. 294-295. 15[12 is obtained by HERON's second approximation.

(36) *Quellen* 3, part 1, p. 172; *Studien*, v. 2, 1932, p. 295-297, 309.

$y^2 + 22\frac{1}{2} = x^2$, when $x = 5$, $y = \sqrt{2\frac{1}{2}}$. The values $y = 2\frac{1}{4}$, $x = 5\frac{1}{4}$ are found in the text. It is easy to verify that $y = 1\frac{1}{8}$, $x = 4\frac{7}{8}$ is another pair of solutions, so that the required y lies between $1\frac{1}{2}$ and $1\frac{1}{8}$. A closer approximation might be readily found.

While many other things in NEUGEBAUER's monumental and extraordinary work might be singled out for comment, the illustrations already chosen will suffice to indicate the wonderful fact that real and varied algebra, without any algebraic notation, was developed by the Babylonians 4000 years ago. As HEATH remarks (37), it is equally extraordinary that

" these developments in arithmetic and algebra should have remained, for most of 1800 years at all events, unknown to, or at least without (so far as we can judge) any traceable effect upon, the Greek pioneers in the same subjects. The first extant Greek treatises which give arithmetical solutions of quadratic equations are those of HERON and DIOPHANTUS. If any Greek mathematician can be supposed to have known, or assimilated, the ancient Babylonian arithmetic and algebra, we can think of no one more likely to have done so than HIPPARCHUS, who evidently knew in all details the results of Babylonian observations and research in astronomy. The discoveries about the Babylonian algebra in any case add fresh interest to the Arabian, attribution to HIPPARCHUS of a work on the art of algebra, upon which ABU'L WAFA wrote a commentary. Did HIPPARCHUS write a book on algebra by way of making known what he found of the nature of algebra in ancient Babylonian tablets and adapting it for use in astronomical and other problems. The passage of PLUTARCH (*De Stoicorum repugnantiis*, c. 29) in which he classes HIPPARCHUS among the ' arithmeticians ' may perhaps be thought to favour such a supposition; but, unless and until fresh documents come to light, the question will presumably remain unanswered. "

Dr. VOGEL suggests that traces of Babylonian algebraic thought may he found in the writings of DIOPHANTUS.

Last February Doctor NEUGEBAUER wrote to me that he had in preparation an *Ergänzungsheft* to his " MKT " *(Mathematische Keilschrift-Texte)*, containing much new material. It seems unthinkable, that means will not be found indefinitely to assure that this young genius may continue his wonderful scholarly achievements under the best possible conditions.

Brown University RAYMOND CLARE ARCHIBALD.
Providence, R. I.
April, 1936.

(37) T. L. HEATH, *A Manual of Greek Mathematics*, Oxford, 1931, p. 529-530.

Mene Mene Tekel Upharsin, a chapter in Babylonian mathematics

I. The Story and the History.
II. The Oracle and its Two Versions.
III. Interpretation of Version 1 : MMTU.
IV. Interpretation of Version 2 : MTP.
V. Mathematics and Story-telling.

I. — The Story and the History

The fifth chapter of the Book of Daniel tells us the story of the fall of Babylon in 538 B.C. One night king Belshazzar was giving a banquet to the lords and princes of his empire, and the wine was served in the holy vessels that once belonged to the Temple at Jerusalem. Suddenly a man's hand appeared and wrote a few signs upon the wall which none of the astrologers of the court could read or interpret. Finally Daniel was brought before the king. He deciphered the mysterious writing as Mene Mene Tekel Upharsin, and gave the following interpretation : " Mene : God has counted the days of your kingdom and brought it to an end. Tekel : You have been weighed in the scales and found wanting. Peres : Divided is your kingdom and given to the Medes and Persians." In the same night king Belshazzar was slain and his kingdom was taken over by Darius the Median.

This story is found to be greatly at variance with the testimony of history. The last king of the Babylonians was Nabonidos and not Belshazzar, and there was no king with the name Belshazzar at all. The conqueror of Babylonia and successor to the last king was not Darius the Mede, but Cyrus the Persian. Nabonidos, the last king, was not slain, nor was Babylon besieged or captured by force. The city opened its gates and surrendered voluntarily to Gobryas, the general of Cyrus, who entered the city without fighting. It is true, the name of Belshazzar has

been found in the cuneiform texts, but he was neither the official king nor the son of NEBUCHADREZZAR, as stated in the Bible. He was the son and heir of NABONIDOS, which latter one had ascended the throne of Babylon as an usurper who never belonged to the family of NEBUCHADREZZAR.

It is evident that the Book of Daniel relates the fall of Babylon in the form of a traditional story known to us, partly at least, also from the narrative of the oldest Greek historians. Both HERODOTUS and XENOPHON report that Babylon was captured while a luxurious banquet was held. The profanation of the golden vessels from the Temple of Jerusalem and the mysterious oracle written upon the wall are two highly dramatic details added by the Hebrew story teller. Essentially, the story seems to be based upon historical facts and actual happenings; only that persons and events belonging to various times are mixed up in the dim memory of oral tradition. Most probably, the story of the siege and capture of Babylon by CYRUS is only "a reflection into the past of the actual siege undergone by the city in the reign of DARIUS HYSTASPIS," as A. H. SAYCE (1) happily suggests. It was DARIUS who first in 521 and then in 515 B.C. had to besiege and recapture Babylon from the hands of two pretenders who arose against him. This will explain why in the Book of Daniel DARIUS, and not CYRUS, is mentioned as the conqueror of Babylon. The conquest of DARIUS as the later, more bloody and more spectacular one, remained in the memory of the people.

That this DARIUS is called the Median and that the Medes are thus introduced as the precursors of the Persians in the conquest of Babylonia, may be due to the fact that in 606 B.C. Nineveh, the capital of Assyria, fell at the hands of the Medes. Popular tradition did not clearly distinguish between Assyria and Babylonia. They form one empire which was divided between Media and Persia. But it was not forgotten that the Median king preceded the Persian CYRUS (2). On the other hand, king BELSHAZZAR, too, is no mere figment of the imagination. Both

(1) *The Higher Criticism and the Verdict of the Monuments*, 2nd ed., London, 1894, pp. 524-529.

(2) Cf. J. D. PRINCE, *Mene Mene Tekel Upharsin*, a Dissertation, Baltimore, 1893, p. 42 f.

pretenders who revolted against DARIUS HYSTASPIS claimed to be the sons and successors of NABONIDOS and lived in the memory of the story teller as the last kings of Babylon. BELSHAZZAR, the real son of NABONIDOS, was a very prominent figure in the life time of his father. He was conspicuous as the commander of the army and as the designated crown prince. One Babylonian text expressly states that in the third year of his reign NABONIDOS intrusted the kingship *(sharrutam)* to his son BELSHAZZAR. Another cuneiform tablet preserves a contract in which the oath is taken both on the name of the king NABONIDOS and of his son BELSHAZZAR. All of which goes to show that in the popular mind BELSHAZZAR was closely associated with his father, the king, as the prospective heir to the throne (3). Hence BELSHAZZAR was confounded with the last king pretending to be the legal heir to the throne, and instead of the insignificant NABONIDOS we find the name of NEBUCHADREZZAR, the glorious founder of the empire. We must not forget that in Daniel V we have before us a record of that unwritten history made by the people, which, as SAYCE (4) well remarked, " blends together in a single picture the manifold events and personages of the past. It is a history which has no perspective, though it is based on actual facts; the accurate calculations of the chronologer have no meaning for it, and the events of a century are crowded into a few years."

II. — THE ORACLE AND ITS TWO VERSIONS

Even as the historian of to-day tries to reconstruct the real facts and historical events, so also will the modern philologist look at the miraculous handwriting as upon the text of an inscription found on an excavated wall or clay-tablet. He will first try to establish the reading of the text, then he will endeavor to find out its true, original meaning, and, in last line, the origin of its connection with the fate of BELSHAZZAR. The first problem, therefore, to present itself for our investigation is : How did the text of the oracle which was written upon the wall read?

(3) See J. A. MONTGOMERY, *Commentary on Daniel* (in The International Critical Commentary), New York, 1927, pp. 66-72; G. A. BARTON, *Archaeology and the Bible*, 4th ed., Philadelphia, 1925, p. 444.

(4) *Loc. cit.*, p. 529.

Unfortunately, the original document with its writing is no more available. The wall bearing the inscription was not preserved, or, rather, has not yet been excavated; hence we are unable to subject it to a re-examination, and have to accept the decipherment suggested by the Book of Daniel. However, the Book of Daniel itself indicates that there were two different versions of the text. In verse 25 we are told that the inscription had the four words : Mene Mene Tekel Upharsin. But in the three verses 26-28, which follow immediately, and in which each word of the text is quoted again and interpreted, the text appears to have read : Mene Tekel Peres. In the exposition of Daniel these three words alone are cited and commented upon. This latter version, containing three words only, is also given by the Septuagint, the Vulgate, and JOSEPHUS, and JEROME expressly states : *Tria tantum verba in pariete scriptum signaverat : mane, thecel, pharas.* Consequently, the majority of the modern commentators seem inclined to accept these three words as the original epigraph (5). Be that as it may, the fact nonetheless remains that the Hebrew Masoretic text, representing a very early Jewish tradition, has both versions, and the philologist therefore has to explain two texts. The one reads : Mene Mene Tekel Upharsin, and the other one : Mene Tekel Peres. In the following we will refer to the first as " Version 1," or, by the initials, as MMTU, and to the second as " Version 2," or MTP.

III. — INTERPRETATION OF VERSION 1 : MMTU

With regard to the reading of the inscription the only discretion left to us was to choose between the two versions. In the interpretation of the text, however, we are given full play to use our own judgment and to try to find out any reasonable meaning, even if it does not have a bearing on the fate of the last king of Babylon. The first successful attempt in this direction was made by the distinguished French archaeologist CLERMONT-GANNEAU, who as the attaché of the French Consulate in Jerusalem

(5) See, for instance, KAUTZSCH, *Die Heilige Schrift des Alten Testaments*, 4th ed., Tuebingen, 1923, II, p. 473; MONTGOMERY, *Daniel*, p. 262; R. H. CHARLES, *Daniel* (in The Century Bible), p. 58, note 4.

made himself famous by the discovery of the Mesha-stone. CLERMONT-GANNEAU had first the idea of treating the phrase MMTU as an inscription. In 1878, while investigating a set of bronze-lion weights from Nineveh preserved in the British Museum, he discovered that the very three words of the oracle, Maneh, Shekel and Peras, appear as the inscriptions of these weights, where they obviously describe the three weights common in the Near East of that time, the mina, the shekel, 1/60 of the mina, and the peras, one half of the mina (6). Consequently, the words MMTU in the oracle of Daniel would simply mean : a mina, a mina, a shekel and half minas (7).

But how does it come that these trivial words, designating weights, were applied to the last king of Babylon and his fate? This difficulty the French archaeologist tries to explain by a number of very ingenious, but rather vague and hardly convincing, conjectures. One of these suggestions was further elaborated by HAUPT, as follows. We know from the Talmud (8) that it was usual humorously to call the small son of a big father *peras ben maneh*, a halfmina, son of a mina, and the big son of a small father, *maneh ben peras*, a mina, son of a half mina. The same popular jest, so argues HAUPT, following the hint of CLERMONT-GANNEAU, may also have been applied, with a slight modification, to NEBUCHADREZZAR and his alleged son BELSHAZZAR. The great NEBUCHADREZZAR was a mina, the rather pygmy BELSHAZZAR was only a shekel, he was the shekel, son of a mina, while Media and Persia were regarded as the two half-minas. According to HAUPT, then, the mysterious sentence would have to be translated : " There have been counted a mina, a shekel and half-minas." The first word Mene would mean " counted " in the sense of " It has been fixed by fate " (9).

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(6) CLERMONT-GANNEAU's article " Mene, Tekel, Peres, etc." appeared originally in the *Journal Asiatique*, juillet-août, 1886, p. 36 ff. and was then reprinted in *Recueil d'archéologie orientale*, I, Paris, 1888, pp. 136-159. An English translation was published in the Quarterly, *Hebraica*, III, Chicago, 1887, pp. 87-102.

(7) In this form CLERMONT-GANNEAU's theory was at once accepted by NOELDEKE, *Zeitschrift fuer Assyriologie*, I, 1886, p. 415, and after him by several others; cf. DRIVER, *Daniel*, p. 69; CHARLES, *Daniel*, p. 57 f.

(8) See *Ta'anit*, 21 *b*.

(9) Cf. PRINCE, *Mene Mene Tekel Upharsin*, pp. 8, 10, 16, and, for the latest views, compare also MONTGOMERY, *Daniel*, p. 262-66.

The idea is ingenious indeed, but hardly satisfactory for the explanation of DANIEL's exposition. If such a popular saying was really current, why did not DANIEL preserve it and why did he so radically change the meaning of all the three words and apply them to BELSHAZZAR alone?

SAYCE (10) suggested to take the first Mene as an imperative, meaning "Count, figure," and the word Parsin in its original sense as "parts, fragments, fractions," which is, philologically, quite correct. Accordingly, the phrase MMTU would signify: "Count, reckon with a mina, shekel and fractions (of a shekel)." This explanation sounds very plausible and would give a phrase well fitting as a heading of one of those numerous Babylonian mathematical texts excavated in the last generation. If we take Parsin to mean simply "parts, fractions," as f.i. the *she*, 1/180 of the shekel (11), then it would fit as the headline of a chapter on fractions. It is, however, quite possible that Parsin became a mathematical term with a specific meaning referring to a special kind of fractions. The writer has two such special terms in mind. Parsin may mean "corresponding fractions" and signify the "reciprocal fractions," or "reciprocals," well known to us from the Babylonian "Tables of Reciprocals" discussed by Professor OTTO NEUGEBAUER (12). The phrase MMTU would mean: "Figure with mina, shekel and their corresponding fractions, or reciprocals." It would give the most appropriate inscription of a Table of Reciprocals as cited by NEUGEBAUER, *ib.* p. 10, which reads:

2	30	1,4	56,15
3	20	1,12	50
4	15	1,15	48
5	12 etc.	1,20	45 etc.

In this table, the numbers in the left column are the integers, and in the right column their reciprocals are given in sexagesimal fractions. For instance: the reciprocal of 2 is 30. (1/60) = 1/2; the reciprocal of four is 15.(1/60) = 1/4; 1,4 is, in the sexagesimal notation of the Babylonians, 1.(60) + 4 = 64. Its reciprocal

(10) *The Higher Criticism and the Verdict of the Monuments*, p. 531.
(11) See NEUGEBAUER, *Vorgriechische Mathematik*, Berlin, 1934, p. 101 f.
(12) *Vorgriechische Mathematik*, p. 6 ff., 10 ff.

is $56.(1/60^2) + 15.(1/60^3) = 1/64$. The value of 1,12 is $1.(60) + 12 = 72$, and its reciprocal is $50.(1/60^2) = 1/72$, etc. Now the last examples represent indeed minas, shekels and their reciprocals.

On the other hand, Parsin may also mean the specific sexagesimal fractions, peculiar to the Babylonian system of notation, in which the sexagesimal scale prevails, and in which the number of 2, 4, 5, for instance, may have the value of $2\ (60^2) + 4\ (60) + 5$, or $2\ (60) + 4 + 5\ (1/60)$, or also $2 + 4\ (1/60) + 5\ (1/60^2)$. It all depends upon what value we ascribe to the first figure at left. We may take it as a talent (60 minas), a mina, or a shekel (13). Now, if we take Parsin in such a sense, the phrase MMTU would be the most logical heading for a chapter on numerical notation. It would give the direction to count 2, 4, 5, as two minas, four shekels and five sexagesimal parts, or as $2\ (60) + 4 + 5\ (1/60)$. This interpretation, however, is good only for the version MMTU, and we have seen above that in all probability the original reading was Mene Tekel Peres. Another and still greater difficulty is that we cannot see why such a prosaic phrase,taken from a mathematical schoolbook, should be treated as the text of the Holy Writ, which is subjected to a homiletical interpretation, and applied to the fall of Babylon?

IV. — Interpretation of Version 2 : MTP

The writer's theory, therefore, is that, in first line, the text originally read : Mene Tekel Peres, as already pointed out. The three words are imperatives and their meaning is : " Count, weigh, break or divide." The vocalization should of course be, accordingly : Meni Tekul Perus. It was recently established by Neugebauer (14) that the Assyrian word *shql*, corresponding to the Aramaic *tql*, commonly transcribed *tkl*, as we do it in this paper, and meaning " to weigh, pay, count," was used as a term for multiplication. The writer, *ib.*, called attention to the parallel use of the Hebrew word *manah*, which means " to weigh, pay,

(13) On the sexagesimal notation of the Babylonians see D. E. Smith, *History of Mathematics*, II, p. 228 ff.; Neugebauer, *loc. cit.*, p. 100 ff.

(14) In *Quellen und Studien zur Geschichte der Mathematik*, B, II, p. 11.

count," and then also " to multiply." It is clear that weighing implies the operation of counting and that in ancient times people paid by weight. In a sense, however, it must also have been connected with the operation of multiplication. For example, if one bag of flour weighs 7 pounds, then three bags of flour will weigh 3 times 7 and the correctness of the product will be tested and demonstrated by the balance. If you figured correctly and obtained 21, then 21 pounds will keep the balance to the three bags of flour. But if you made a mistake and figured it to be 20, and you put only 20 pounds on the scale, then the balance will show your error. Hence the three words " Count, Weigh, Break " may be taken to signify the three fundamental mathematical operations : Counting, Multiplication, and Division.

Today we are used to a sequence of operations in which addition and subtraction come before multiplication and division. But this was not always so. In ancient times, the first and fundamental operations were multiplication and division. Addition and subtraction were implicitly included in the art of counting or in the system of notation. Since the primitive numerals of the Egyptians and Babylonians were only pictorial ideograms, imitating the actual counting by placing the strokes for the units, or the marks for the tens and the hundreds, side by side, addition meant mechanical adding, and subtraction, mechanical removing of the symbols (15). That is the reason why addition and subtraction are entirely missing in ancient mathematics, and multiplication and division figure as the first operations. Even in mediaeval times, when addition and subtraction do appear as special operations, multiplication and division retain their traditional place, at the beginning, and addition and subtraction follow afterwards. Thus, f.i., SAVASORDA (c. 1120), IBN EZRA (c. 1150), FIBONACCI (c. 1202) and several other algorithmists have the sequence of Multiplication, Division, Addition, Subtraction, etc. (16).

The three words MTP, " Count, Weigh, Break," therefore, appear to us as the headings of three chapters, or as the inscriptions of three clay-tablets, dealing with the three elementary operations

(15) See the writer's paper on " Hebrew Numerals " in the *Proceedings of the American Academy for Jewish Research*, IV, 1932-33, p. 54 f., and note 4 *ib.* and cf. also NEUGEBAUER, *Vorgriechische Mathematik*, p. 17.

(16) Cf. SMITH, *History of Mathematics*, II, p. 36.

of Babylonian mathematics. It is true, that if we had to deal with these three words as an independent, isolated text, the interpretation of CLERMONT-GANNEAU would be equally admissible, and we could identify them as the names of the three familiar weights. Taken with the context, however, the theory of CLERMONT-GANNEAU cannot be sustained, as was shown above, while our argument is clinched by the commentary of the verses 26-28. In the writer's opinion, these verses had, originally, nothing to do with prophetic oracles and warnings, but were of a mathematical and paedagogic nature, commenting upon the three mathematical terms MTP. They impress us as a kind of nursery-rhymes, adapted to the mentality of the young schoolboy, and conveying a double meaning. On the one hand, they had to indicate the nature of the operation in a short, epigrammatic form, and on the other hand, they were intended to form auspicious sentences, promising prosperity and success, or expressing love and affection.

Thus in v. 26 the sense is : " Count, God has counted your kingdom and made it *full, complete.*" This conveys, first, that the boy has to count, patiently and carefully, till he makes complete the full number of 10, 60, or 100, etc. If you do this, my son, the fatherly pedagogue tells him, God will count and make complete the number of the provinces of your kingdom. The boy is, fondly and auspiciously, addressed as the young prince of a great empire. Count till sixty, and God will give you an empire with sixty provinces. *Hashlem* means, originally, " to make full, complete," like the Hebrew *millē* in *Exodus* 23:26 : " And I will bring to completion the full number of your days." In v. 27 the boy is told to execute his multiplication with great care. For it will be tested in the balance, and, if not correct, the one scale will be wanting in weight. The wealthy and affectionate mother used to weigh her child daily. The story is told in the Talmud (17) of one mother who used to dedicate to the Temple the daily increase in the weight of her child in an equal amount of gold. In the twelfth century, ROHESE, the wife of GILBERT BEKET, the portreeve of London, weighed her son THOMAS each year on his birthday against money, clothes and

(17) *Yoma*, 38 b.

provisions which she gave to the poor (17*a*). We may well imagine how the loving mother would scold her child for not eating enough, perhaps with the words : "You have been weighed in the scales and found wanting." You have to eat more and become a big, strong boy. This familiar and affectionate exhortation of the mother was used as the motto for multiplication, which was explained in terms of weighing. Multiply and figure correctly. Otherwise, you will be weighed in the balance and found wanting. The balance will mercilessly disclose your error. The epigram for division, in v. 28, again took up the motive of the king and his empire. You are the ruler of a great kingdom, but you cannot govern it yourself, so you have to divide your kingdom into two parts, evenly, and give one part to the Medes and the other part to the Persians.

It should be noted here that the operation of division is introduced in its most elementary form of mediation or halving (18). It may be remarked, furthermore, that the Hebrew-Aramaic *malkhūt*, "kingdom," has the original meaning of "wealth, possession." It corresponds to the Arabic *mal* and Hindu *dhanam*, which signify "possession, money, capital," and have been used in their rhetoric algebra as the terms for the positive quantity, the equivalent of our symbol x. Hence the word *malkhūt*, too, may have been used as a mathematical term.

It is now clear, so the writer believes, that if these four verses, 25-28, had come down to us as an isolated text, without any connection with the rest of *Daniel* V, this mathematical interpretation would have been regarded as natural and logical. It is also evident that these mathematical texts cannot be very old, like some of those Babylonian mathematical texts that go back to 2000 B.C. or earlier. They must have been formulated after the conquest of Babylon in 538 B.C., when Media and Persia were popularly considered as the two heirs of the great Babylonian empire. Little wonder, therefore, that the text, especially v. 28, seemingly dealing with the fall of Babylon and its division between Media and Persia, suggested to the much later story-

(17*a*) See J. R. GREEN, *A short history of the English people*, I, p. 131.

(18) See SMITH, *History of Mathematics*, II, p. 34, and cf. also the writer's "Terminology of Multiplication" in the *Hebrew Union College Annual*, VI, 1929, p. 250, note 13.

teller and author of *Daniel* V, the thought of applying the whole passage in a homiletical way to BELSHAZZAR, the last king of Babylon. Of course, in order to adapt the sentences to the new subject, their meaning had to be changed. The originally auspicious phrases became now ominous, assuming a sinister character and foreboding the doom and destruction of BELSHAZZAR. Thus the sentences were interpreted : " God has counted the *days* of your kingdom and *has brought it to an end*, has *finished* it. BELSHAZZAR has been weighed in the balance of *justice* and found wanting in merits. Therefore his kingdom was *broken up* and given to Media and Persia." In the original, mathematical text, *malkhūt*, kingdom, was used, both in v. 26 and 28, consistently as a mathematical term for the sum total of the parts, representing the number to be counted or divided. In the later homiletical interpretation the use is rather inconsistent. In v. 26 the *days of the kingship* are counted, while in v. 28 the *quantity of the kingdom* is broken up and divided.

We are now also in a better position to explain the origin of the version MMTU. Originally, it may well have been a marginal gloss, explaining the word Mene in a different and more serious manner. In words which closely resembled the text MTP, the gloss instructed the disciple to count on a sexagesimal scale, with minas, shekel and sexagesimal fractions, thus preparing him for the understanding of the Babylonian system of notation. Because of its close resemblance, the gloss found its way into the text, and displaced the original reading of MTP. Its character as gloss is still apparent in the repetition of the words : *U-dena ketaba di reshim*, " This is the writing which was inscribed," in v. 24 and 25.

V. — MATHEMATICS AND STORY-TELLING

In all likelihood, the story-teller was well aware of the true meaning of the sentences, and the audience, too, must have been familiar with them. In the application of these popular epigrams of a mathematical schoolbook to his story, lay the peculiar charm by which the story-teller tried to gain the attention and applause of his public. In ancient times, story-telling was an institution and profession. The reciter was not only a public entertainer,

but a teacher and preacher, a journalist and propagandist. Like the novelist of our times he would be eager to display his familiarity with the latest results in science and religion. The masses, too, are always eager to learn, but they loathe the dry and dull schoolmaster and prefer to gather their information from the minstrel, the master of fiction and style. Hence we may find in the stories and epics of all the times and all the races, our modern fiction not excluded, curious relics of knowledge, in scattered bits and fragments, strangely distorted and adapted to please the taste of the audienc. The story-teller knew everything differently and better than the professional schoolman. Take, f.i., this simpleton and bore of a mathematics teacher. Day out and day in the will grind with his pupils the three operations and the revelant phrases. But he has no idea of the deep, mystic wisdom hidden in them. Originally, they were a weighty, portentous oracle, they played a part in the destruction of the great Babylonian empire. The official astrologers and professors of the imperial court of BELSHAZZAR were unable even to read them, much less so to interpret them. It was the great prophet and mystic DANIEL who knew what it really meant, and he, the humble story-teller, does also know something about it. Quite incidentally, the minstrel finished his narrative with the significant detail that DANIEL, his predecessor, was royally rewarded with a purple garment, a chain of gold, and a high office. A clear hint and reminder to the audience not to forget about his own proper remuneration.

A somewhat more serious use of a mathematical operation for the *Agadah*, this is the Hebrew term for the genre of story-telling, is to be found in the *Mekhilta* (19). The passage was taken over into the *Haggadah*, the ritual commemorating the deliverance from Egypt, which is still at present chanted by the Jews at their solemn home services during the first two evenings of the Easter festival. There we read : " Rabbi Jose, the Galilean, (c. 125 A.D.), says : How do you know that the Egyptians, who were afflicted in Egypt with ten plagues, were afflicted by the sea with fifty plagues? Concerning Egypt what does the Bible say? ' And the magicians said unto Pharaoh, this is the *finger* of God ' (*Exodus* 8: 15). And by the sea what

(19) Ed. HOROVITZ, Frankfurt a. Main, 1928, p. 114.

does it say? 'And Israel saw the great *hand* which the Lord wrought' (*Ex.* 14:31). With how many plagues were they afflicted by a *finger?* With ten plagues. Say now: In Egypt, they were afflicted with ten plagues, but by the sea they were afflicted with fifty plagues."

I have here tried to give a literal translation of the passage in order to preserve the primitive terminology of this early instance of rhetoric algebra in Hebrew. In our modern symbolic parlance we would say: Finger : Hand = 10 : x; 1 : 5 = 10 : x; x = 50. We have here the earliest specimen of the Rule of Three in Hebrew literature (20). The *Haggadah* was intended for the instruction and amusement of the children. R. Jose achieves both ends by introducing into the midst of the serious religious services a light problem of algebra. In the school, the children always learned about the ten plagues of the Egyptians. Now comes R. Jose and proves to them, in all earnest and by the strict rules of algebra, that by the sea the naughty Egyptians had to suffer some fifty plagues more. The problem is introduced in the form of a puzzle, and belongs properly into the class of mathematical recreations, whose chief purpose it is to provide intellectual pleasure (21). With the treatment of MMTU in the Book of Daniel it has in common the Agadic, homiletical character. To both of them we may, therefore, apply the term of "Agadic, or Homiletical Mathematics."

New York City. SOLOMON GANDZ.

(20) This may, at the same time, serve as a supplement to the writer's short notice on the history of the Rule of Three in *Isis*, XXII, 1934, p. 220-22.

(21) See the instructive chapter on mathematical recreations in SMITH, *History of Mathematics*, II, p. 532 ff.

Third note on date culture in ancient Babylonia

To the notes which I have already published (*Isis* 21, p. 8-13, 4 pl., 1934; 23, 251-2, 1935) and to SOLOMON GANDZ's article on " Artificial fertilization of date-palms in Palestine and Arabia " (*Isis* 23, 245-50, 1935) may still be added the following information culled from C. J. GADD : *The Assyrian sculptures* (British Museum 1934, p. 51) :

" It is to be supposed that all the monstrous figures of ' genii ' are in some fashion connected with the same order of ideas, namely, the securing of safety and prosperity to the building and its inhabitants by the visible presence of beneficent powers. So far as these have the office of driving away demoniac influences, their function is now well understood. But there are also certain sculptures, especially those which include the ' sacred tree,' a highly artificial creation of which the purport is not fully made out. It has been suggested that the figures bearing a cone and a small pail which stand beside the tree and seem to touch it with their cones are carrying out an operation which is known to be essential to the successful production of dates from the date-palm, that is, applying the male inflorescence to the flowers of the female tree, so that these may be fertilised by the pollen. The male inflorescence has somewhat the shape of the cones held by these genii (though they have more often been regarded as pine-cones), and this explanation would well suit the cases in which the figure with cone and pail is touching the tree. Moreover, there is textual evidence, noticed above (1), that some of these magical figures carried the date-spathe, and there is also a sculpture (117110) from Tell Ḥalaf in northern Mesopotamia,

(1) The fish-men in the Nimrûd Gallery are required to be fashioned thus " painted with gypsum [i.e., white], cloaked in the skin of a fish, holding in their right hands the date-spathe..."

which shows a man who has climbed up a ladder to the head of a palm apparently carrying out this operation. Nevertheless, this interpretation encounters great difficulties, for, first, the 'sacred tree' is manifestly no natural tree, though its leaves have the form of palmettes, but an artificial object. Further, the genii do not always smear it with their cones, but sometimes pluck it, or else it is female figures which stand beside it, or even the king. The fertilization, too, in practice is not done by merely wiping off the pollen on to the flower, but by tying the male inflorescence beside the flower. And, most remarkable of all, it is not usually the tree at all which the genii touch with their cones, but the king, or his hand, or his minister, or his bow. In view of all this, it is hardly possible to maintain the idea that the ceremony admittedly magical, is simply the repetition of a particular detail in palm culture, especially as it might also be added that Assyria is now, and probably always was, outside the region in which palms are productive of dates.

Everything, on the contrary, goes to show that the 'tree' is rather the source than the recipient of a magical virtue. Alike those who pluck it, and those who touch it with their cones, the goddesses who hold towards it chaplets of fertility-symbols, the king who makes towards it a ritual gesture of the hand, and the god in the winged disk who seems to dispense blessings from above it, agree in suggesting that a powerful influence radiates from the sacred branches, and is conveyed by the touch of the cones, dipped in a lustral fluid contained in the small pails. When the king's person, accoutrements, and servants are so touched the magic is conveyed to them, so that they are immune from disaster and endowed with supernatural force."

I am especially grateful to Dr. GADD for allowing me to reproduce this passage because it tends to infirm my own tentative conclusions.

His reference to the Tell-Ḥalaf sculpture is tantalizing, and I would have liked to publish a reproduction of it. Unfortunately this cannot yet be done. Says Dr. GADD in a letter to me (3510.01): "I am sorry that it is not possible to send you a photograph of the relief from Tell Ḥalaf, since this slab was discovered by Baron von OPPENHEIM, who has not yet published it, and it is

therefore subject to an agreement that it shall not be published elsewhere in anticipation of him " (2).

In her *Monocotyledons* (Cambridge University Press 1925, p. 192) Mrs. AGNES ARBER refers to a paper by Miss C. GARLICK : Note on the sacred tree in Mesopotamia (*Proceedings of the Society of Biblical archaeology*, vol. 40, 111-12, 1918) wherein she describes the artificial pollination as it is carried on to-day by the Arabs of Iraq.

" To ensure the effective use of the pollen, it has been carried from one tree to another, and applied by the hand of man from time immemorial, and it is reasonable to suppose that the method adopted by the Arabs of to-day should throw light on the details of the temple scene. The palm blossoms during February and March, even at the present day the trees are garlanded with ribbons in honour of the festival. The stamen-clusters produce such an enormous quantity of pollen that one male-flowered palm is enough to supply effectively a great many fruiting-trees, and, incidentally, space is saved. The Arab about to undertake the work is provided with a bag slung on his arm, and a cord to help him in climbing. The ends of this cord are tied so that it encircles his body under the arms, and is also round the palm stem which he has to climb. As he makes his way up he supports the cord, at successively higher points, on the tough remains of the leaf-bases. He must first climb the male palm for the stamen clusters, and then these, or compressed masses of pollen, are put in the bag while he climbs the fruiting trees. When placing the pollen on the pistilate flowers, which are near the top of the crown, he must be well supported by his cord, in order that both hands may be free for his somewhat difficult task."

Miss GARLICK then proceeds to discuss the Assyrian representation of the tree (see the illustrations in our first paper, *Isis*, vol. 21, chiefly pl. 3) and shows that the typical basal leaves are shown at the base of each part in profile and curved back. She concludes :

" It needs, perhaps, some stretch of imagination to see here (3) the picture of a male-flowered palm growing in the midst of a grove of female-flowered trees, all festooned together for the festival with loops and ends of drapery, in origin a necessity but now merely an adornment.

(2) A letter addressed to Herr VON OPPENHEIM on Oct. 14, 1935 remained unanswered.

(3) See our pl. 3 in vol. 21.

As regards the winged figure, the satchel and the pollenmass need no explanation. The long wings and the bird headdress (hawk or eagle) adopted by the royal or priestly ministrant in the temple scene are again a matter for speculation. It may be that the actual performer of the work above described did, in remote times, masquerade as the wind, since he was consciously doing the wind's work."

GEORGE SARTON.

Alte Gedanken und neue chemische Theorien [1]

1. *Chemische Ausbildung allgemeiner Gedanken*

In Wissenschaften, deren Erkenntnismaterial durch experimentelle Arbeit, durch viel Handwerkerliches enthaltende Methoden, vor allem aber auch durch Geschicklichkeit und Kunstgriffe erarbeitet wird, treten Theorien gern nur im Anschluss an neue experimentelle Ergebnisse auf. Sie erscheinen dann auch als Ergebnis dieser neuen Versuche und gehen über sie nach Ziel und Absicht nur darin hinaus, dass sie möglichst vielerlei bekanntes Versuchsmaterial umfassen und erklären wollen. Da scheint zunächst von alten Gedanken keine Rede zu sein; denn wollen die Theorien so neu sein wie die Versuche, aus denen sie abgeleitet wurden, so sollen sie zugleich über vorher Bekanntes hinaus dringen. So sind in der Tat neue theoretische Vorstellungen entwickelt worden, deren Unabhängigkeit von alten Gedanken schon durch die subjektiven Erscheinungen belegt wird, welche sie bei dem einen oder andern Chemiker und Physiker hervorrufen, der den älteren Gedanken anhängt. Und da dies nicht nur heute im Gefolge von tiefgehenden Wandlungen im naturwissenschaftlichen Untergrunde eines Weltbildes zu beobachten ist, da es vor fünfzig und vor hundert Jahren und stets gegenüber neuauftretenden Theorien festgestellt werden kann, so sollte daraus eine Summierung des Abstandes zwischen alten Gedanken und neuen Theorien hervorgehen und beinahe berechenbar sein.

Wenn man aber so etwas wie einen Versuch zu einer solchen Berechnung anstellt, so stösst man sehr bald auf die Notwendigkeit, eine Trennung vorzunehmen. Eine Theorie ist weder nach ihrem

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(1) Zum Teil vorgetragen vor der „Rheinischen Gesellschaft für Geschichte der Med., Naturwiss. u. Technik" in Leverkusen, 13. V. 1932.

gedanklichen Gehalt, noch nach ihren geschichtlich gewordenen Bestandteilen eine Einheit. Die Benzoltheorie von KEKULÉ, an der man wie an wenigen die grosse Bedeutung der Theorien in der Chemie auch für die chemische Technik und auch die Anerkennung dieses Verhältnisses nachweisen kann, lässt sich in geschichtliche Tiefenschichten zerlegen und gewissermassen horizontal aus der Verbindung mit verschiedenen Gedanken grösserer und geringerer Allgemeinheit konstruieren. Wenn die vertikale Achse dabei einer mit dem Zeitraffer aufgenommenen geologischen Schichtung verglichen werden kann, die horizontale Achse mit einem Durchstich durch Gedankenkreise verschiedener Weite, so besteht nach einer dritten Koordinate eine Beziehung von der Art, dass je allgemeiner und zugleich abstrakter eine Theorie ist, desto älter auch ihr gedanklicher Inhalt gerechnet werden kann. Als ein Beispiel für diese Beziehung denke man etwa an das Relativitätsprinzip, dessen allgemeinster Gehalt schon bei den ältesten Denkern ausgesprochen ist, so dass sie jeder Philosoph verstehen kann, während seine Auswertung und Anwendung auf die Theorie des Lichtes und der Materie nicht einmal jedem modernen Physiker von Fach ohne grosse Anstrengung zugänglich ist. Gerade dann mag man auch sehen, dass der Gehalt an altem Gedankengut nicht vor zeitlicher Veränderung schützt. Vielmehr scheint es so zu sein, dass sich jede Zeit mit ihren Erkenntnismitteln aufs Neue mit solchen alten Gedanken einzulassen hat. Dadurch, dass sie das Alte scheinbar nur anwendet, gestaltet sie es und macht sie es aufs Neue lebendig. Solche Gedanken dauern, aber sie sind nicht unabhängig von der Zeit; man kann an ihrer Gestaltung die Geschichte eines naturwissenschaftlichen, in anderm Bereiche auch eines philosophischen Gebietes ablesen. Was hat der Gedanke einer atomistischen Struktur der Materie für eine reiche Geschichte! Ein grosser Teil von der Entwicklung der Physik und der Chemie lässt sich unter diesem Gesichtspunkte darstellen. Geschichtslos im Sinne zeitlicher Konstanz sind nicht die grossen Gedanken, sondern die einzelnen besonderen Befunde. Dass Schwefel beim Erhitzen sublimiert, wird nach Erkennung und Verbreitung dieses Befundes stets anerkannt bleiben; aber ob Schwefel ein Element sei, das ist eine lange diskutierte und verschieden aufgefasste Vorstellung gewesen.

Jeder kennt einige alte Gedanken, die in unseren heutigen chemischen Theorien noch vorhanden und sehr lebendig sind : Erhaltungsgesetze, Kausalitätsvorstellungen, Atomistik. Bei aller ihrer Allgemeinheit, der ihr Alter entspricht, haben sie nicht nur einen allgemeinen Grund für die Errichtung chemischer Theorien abgegeben, sondern auch an entscheidenden Stellen ganz spezielle Erklärungen ermöglicht.

2. *Das Erhaltungsgesetz*,

angewandt auf Stoffe, bildet eine der Grundgleichungen, durch die das neue System der Chemie sich von der Vorgängerin, Phlogistonlehre, unterschied. Aus dem Erhaltungsgesetz für die Massen entspringen BOYLES und LAVOISIERS Versuche, die Umwandlung von Wasser in Erde als eine solche der Glaswand unter dem Einfluss des Wassers zu erklären. So liefert das Erhaltungsgesetz an vielen wichtigen Stellen der Entwicklung der Chemie eine Grundgleichung zwischen den Reaktionspartnern. Allerdings konnten sich auch Fehlschlüsse darauf aufbauen, wenn nicht alle an der Reaktion teilnehmenden Stoffe berücksichtigt wurden. Dann entstanden Beweise für den Sauerstoffgehalt des Chlors oder den Wasserstoffgehalt des Stickstoffs, dann konnte VAN HELMONT zeigen, dass die Pflanze, da er ihr nur Wasser als Nährsubstanz dargeboten hatte, eben auch nur aus Wasser bestünde. So allgemeine Gesetze beweisen nur die in ihrer Dimension von Allgemeinheit gelegenen Anschauungen und erfordern zusätzlich die Kritik der Einzelheiten.

Wenn wir aber fragen, welche Sicherheit oder Entscheidungsmöglichkeit wir dafür haben, dass das Grundgesetz seine Gültigkeit und stete Anwendbarkeit besitzt, dann geraten wir zu leicht in das Gebiet der Erkenntnistheorie, das wir allerdings hier nicht ganz vermeiden können. Man kann mit KANT solch allgemeine Gesetze als aus Erkenntnissen a priori fliessend anerkennen; man kann auch Gründe dafür zusammenstellen, dass nur vereinfachend beschreibende, aus den Erfahrungen und a posteriori gefolgerte Gesetze bestünden. Im ersten Fall sind wir bei einem rein philosophischen Element angelangt; aber auch in dem zweiten Fall sollte man doch betonen, dass nicht diese oder jene Erfahrung, sondern ein möglichst umfassendes System von Erfahrungen in einem solchen Gesetze ausgedrückt wird.

3. *Kausal-Gesetz*

Nicht für das Erhaltungsgesetz, aber für ein anderes altes Gesetz von, man möchte sagen, noch grösserer Allgemeinheit erleben wir gerade die Auseinandersetzung darüber, ob es absoluten, a priorischen Wert hat oder von Einzelerfahrungen abhängt und daraus bewiesen oder abgelehnt werden kann. In der HEISENBERGschen Unbestimmtheitsrelation wird gezeigt, dass es unmöglich ist, von einer gewissen Art von Vorgängen alle unabhängigen Variablen zu bestimmen. So lassen sich von Elektronen (und von Protonen) die beiden notwendigen Bestimmungsstücke, Ort und Geschwindigkeit, nur mit einer gewissen Variationsbreite bestimmen, und zwar derart, dass das Produkt aus den beiden Variationsbreiten ungefähr die Dimension des PLANCKschen Wirkungsquantums besitzt. Je genauer also der Ort bestimmt wird, desto ungenauer lässt sich die Geschwindigkeit erkennen und umgekehrt. Diese Aussage betrifft nicht nur ein besonderes Beobachtungsverfahren, sondern sie enthält in demselben Sinne ein Naturgesetz, wie es dasjenige von den Quanten ist. Der Weg, den ein kleinstes Materieteilchen zurücklegt, kann also nicht eindeutig genau vorausgesagt werden. Das Kausalgesetz besagt, dass alles Geschehen nach Erkenntnis seiner Ursachen genau voraussagbar sei. Daher ist hier ein Widerspruch zum Kausalgesetz aufgedeckt, und mit der Ausdehnung, die man solchen für ganz besondere Fälle gemachten Erkenntnissen gern gibt, erblüht daraus die Behauptung von einer Widerlegung des Kausalgesetzes. Wer solche Verallgemeinerung nicht mit leichtem Herzen oder metaphysischem Schauer vorzunehmen geneigt ist, der wird vielleicht der Bedeutung dieser neuen Erkenntnisse besser gerecht, ohne sie geringschätzen zu müssen. Er wird dann feststellen, dass es sich um eine gesetzliche Festlegung der Ungesetzlichkeit unter der Herrschaft des Kausalgesetzes handelt und sich vielleicht der Stellungnahme von M. SCHLICK anschliessen können: „Aber es ist schon eine grosse Errungenschaft der modernen Physik, gezeigt zu haben, dass eine Theorie von einer derartigen Struktur in der Naturbeschreibung überhaupt möglich ist; es bedeutet eine wichtige philosophische Verdeutlichung der Grundbegriffe der Naturwissenschaft. Der prinzipielle Fortschritt ist klar: es kann jetzt *in demselben Sinne* von einer empirischen Prüfung

des Kausalprinzips gesprochen werden, wie von der Prüfung irgend eines speziellen Naturgesetzes (2)".

4. *Der Stetigkeitsgedanke*

könnte bei oberflächlicher Betrachtung in der Chemie durch die Atomistik abgelöst und überwunden zu sein scheinen. Ich habe gelegentlich (3) zu zeigen versucht, dass dies ebensowenig richtig ist, wie wenn man behaupten wollte, der Stetigkeitsgedanke sei in der Mathematik durch die Differenzialrechnung ersetzt und damit abgetan und widerlegt. Die Atomistik in ihrer jeweiligen Gestaltung ist der beste und direkte Ausdruck dafür, was zu einer bestimmten Zeit der in der Chemie verwirklichte Sinn der Vorstellung einer stetig strukturierten Materie ist. Bei solcher Betrachtungsweise versteht man recht gut, wie im Zusammenhang mit einer Entwicklung, die in eine Ausdehnung der Diskontinuitätstheorien zu münden schien, doch in Wirklichkeit das Kontinuitätsprinzip in einer neuen Bestimmtheit und Bestimmungsfähigkeit wiedererschien.

Diese vier Gedanken hohen Alters, die sich in Erhaltungsgesetz, Kausalgesetz, Kontinuitätsprinzip und Atomistik zu erkennen geben, bilden einen ersten grossen und weiten Kreis, wenn man die auch in neuen Theorien wiederkehrenden alten Gedanken zu ordnen versucht. Einen zweiten engeren Kreis können wir danach ausfüllen mit den Gedanken der Elemente, dem Begriff des Stoffes im Verhältnis zu Form und Eigenschaften und schliesslich dem Chemismus im Verhältnis zu dem ganzen Naturgeschehen, zu den anderen darin anzuerkennenden Kräften, etwa der Lebenskraft.

5. *Elemente und Stoffe*

Es gibt Elemente, die freiwillig und sogar unbeeinflussbar sich in andere umwandeln; für einige Elemente liess sich auch zeigen, dass sie unter dem Einflusse von Energien hoher Intensität zerlegt werden, wobei andere Elemente von kleinerem Atomgewicht entstehen, vor allem Wasserstoff. In diesem Zusammenhang

(2) *Naturwiss.*, 19 (1931), S. 153.
(3) *Naturwiss. Wochenschrift*, 36, 705 (Jena, 1921).

gewann jene Hypothese neue Bedeutung, die vor hundertfünfzehn Jahren von dem englischen Arzt und Chemiker PROUT aufgestellt wurde: es gäbe nur eine Urmaterie, den Wasserstoff, und alle andern Elemente seien sozusagen Verbindungen derselben.

Ist das ein Zufall? Oder soll man annehmen, dass PROUT in einer Art Vision das wahre Wesen der Elemente wie in einer für die Zukunft wegweisenden Offenbarung geschaut habe? Aber was er sagte, hing ja auch mit älteren Gedanken zusammen und wandte sie nur auf die neuen chemischen Messungsergebnisse an. Wenn wir heute wieder darauf zurückkommen, so sind auch nicht ganz allein die experimentellen Befunde dafür grundlegend; denn ebenso wie wir in der organischen Chemie bei vielen Reaktionen Umlagerungen der Atome annehmen, könnte man vielleicht auch bei den Elementen mit Umlagerungen der Elektronen innerhalb und ausserhalb des positiven Atomkerns auszukommen versuchen. Jener alte Gedanke liegt aber auch unserm heutigen Denken näher.

Für die Beziehung zwischen *Stoff* und *Eigenschaft* entwickelten die klassischen Atomistiker und ihre Nachfolger im sechzehnten und siebzehnten Jahrhundert sehr anschauliche, darum aber auch „grobmaterialistische" Vorstellungen. Stechender Geschmack des Schwefeldioxyds käme davon, dass seine kleinsten Teilchen scharf geschliffene kleine Messerchen seien; eine spezifisch schwere Substanz bestünde auch aus schweren groben Atomen; eine leicht flüchtige Substanz dagegen hätte leichte feingebaute Urteilchen. Solche Vorstellungen haben z.B. auch dem Alkohol seinen Namen verschafft; denn wie wir aus den Forschungen E. O. VON LIPPMANNS wissen, bezeichnet dieses aus dem Arabischen stammende Wort so etwas wie eine besonders zarte Substanz, ein feinstes Pulver. Über derartige Vorstellungen war die Chemie schon einmal weit hinaus. Aber sie ist neuerdings in gewissem Umfange in deren Nähe zurückgekehrt. Dies hängt mit der Auffindung neuer Methoden für die Erforschung zwar nicht der Form der Atome, aber der atomaren Struktur der Moleküle zusammen. Darum gewinnt es jetzt neuen Sinn, etwa die schmiertechnischen Eigenschaften einer organischen Verbindung darauf zurückzuführen, wie die Atome im Molekül gelagert sind oder die Fähigkeit zur Bildung von flüssigen Kristallen auf die stabartige Anordnung

der Atome, die langgestreckte Form z.B. der Paraverbindung, im Gegensatz zur Orthoanordnung.

Neben dieser Zurückführung der Eigenschaften auf mechanische Strukturen gibt es die ebenso alte Erklärung durch besondere Eigenschaftsträger, nämlich Stoffe, von denen man nichts anderes und darüber hinaus wusste, als dass sie die zu erklärende Eigenschaft besässen. Geht man einen solchen Weg zu Ende, so kommt natürlich nichts anderes in Sicht, als jedem Stoff seine Eigenheit noch einmal zu bescheinigen, ungefähr mit derselben Tautologie, die NIETZSCHE bei KANT findet, der das Zustandekommen unsrer Erkenntnis mit der Formel : „vermöge eines Vermögens" erkläre. So ist jene Deutungsweise natürlich nicht gemeint; sie enthält vielmehr den guten Sinn, allgemeiner vertretene Grundeigenschaften herauszuheben und dann die Schwere durch den Gehalt an Erde und die Verbrennlichkeit durch den an Schwefel zu kennzeichnen. Gewiss hat F. PANETH teilweise Recht, wenn er sich gegen die manchmal anzutreffende Angabe wendet, die vier Elemente des ARISTOTELES seien nicht Stoffe, sondern Kombinationen der vier Grundeigenschaften kalt, warm, trocken, feucht (4); darum entspricht nach ARISTOTELES ein Element nicht jeder einzelnen von diesen Eigenschaften, sondern dem Beisammensein von je zwei Eigenschaften. So ernst es auch gemeint war, dass diese Elemente Stoffe seien, so wichtig war doch auch ihre Rolle als ursächlicher Träger der Eigenschaften, die man zu erklären wünschte. Man braucht nur BOYLES gründliche Polemik dagegen in seinem „Skeptischen Chemiker" zu lesen, um sich davon zu überzeugen. Wie sehr eine solche Auffassungsweise in unsern Denkmethoden begründet liegt, das sieht man an vielen Beispielen aus jeder und auch aus neuester Zeit. Eines davon mag hier etwas näher beschrieben werden :

Organismen reagieren auf die Zufuhr von artfremdem Eiweiss durch die Bildung von Abwehrstoffen, die in der Biochemie den nicht sehr schönen, aber allgemein angewandten Namen : Antikörper erhalten haben. Diese Reaktion braucht in typischen Fällen eine gewisse, meist mehrere Tage umfassende Zeit. Nach ihrem Ablauf ist eine Überempfindlichkeit gegen den Stoff ein-

(4) *Schriften d. Königsberger Gelehrten Ges. Naturwiss. Kl.*, 8. Jahr, Heft. 4, Halle, 1931, S. 102.

getreten, der die Reaktion veranlasste. Diese Erscheinungen sind in einer gewaltigen Fülle von Arbeiten näher untersucht worden, sodass ihre Wirklichkeit trotz der gelegentlichen Unstimmigkeiten feststeht. „Überblickt man nun alle diejenigen Stoffe, die befähigt sind, im tierischen Organismus die Bildung von Antikörpern auszulösen, so zeigt es sich, dass diese Substanzen, die man als „Antigene" zusammenfasst, darin übereinstimmen, dass sie im chemischen Sinne völlig unbekannte Gebilde darstellen (5)."

Noch unbekannter, wenn eine solche Steigerung erlaubt ist, als die Antigene sind die Antikörper. Was fängt man mit solchen Unbekannten an? Wir sahen es eben: Man behauptet zunächst von ihnen, sie seien Stoffe. Zwar weiss man von ihnen nichts, als die eine Eigenschaft, diese besonderen Wirkungen hervorzurufen; aber daran erkennt man sie, und man kann gewisse Versuche mit den Mischungen anstellen, die man in verschiedener, aber bestimmter Weise den Organismen entnimmt. Sind es „Toxine", so lassen sich die Antitoxine dazu genau titrieren und ihre Qualitäten durch Vergleiche erkennen. So erfahren wir vielerlei über die Antitoxine, was von grosser praktischer Wichtigkeit ist, obgleich wir sagen müssen: „Unsere Kenntnisse über die chemische Natur der Antitoxine sind äusserst spärlich. Wir wissen nicht einmal die erste Frage zu beantworten, ob sie Eiweisskörper sind, oder ob sie nur mit den Eiweisskörpern der Sera so eng verbunden sind, dass sie von ihnen nur sehr schwer getrennt werden können" (6).

Man untersucht, wie sich der unbekannte Bestandteil in den spezifischen Gemischen gegen Licht und Luft, gegen Säuren oder Alkohol, gegen Fermente oder Adsorbentien verhält. Was wir in Wirklichkeit beobachten, ist aber nicht das Verhalten des Stoffes, sondern Bleiben oder Verschwinden seiner, richtiger gesagt: einer Aktivität. So arbeiten wir mit Agglutininen, Präzipitinen, Amboceptoren, Komplementen und Anti-Komplementen, Tropinen, Antiaggressinen, Hämolysinen und ihren Unterarten und Gruppen. Benutzen wir da nicht den alten und an anderen Stellen für abgetan erklärten Gedanken, nach welchem jede spezifische

(5) H. Sachs, in „Handbuch d. Biochemie d. Menschen u. d. Tiere" hg. C. Oppenheimer, 2. Aufl., Bd. 3, S. 5 (1925).

(6) H. Schlossberger in „Handbuch" Oppenheimer, Bd. 3, S. 119.

Eigenschaft durch einen spezifischen Stoff erklärt werden müsse? Wir können uns sogar auf grosse Erfolge berufen, die in den letzten Jahrzehnten durch solches Verfahren erzielt werden konnten: In der Chemie der Radioaktivität hat man besonderen Strahlungsarten und Strahlungskurven neue Stoffe, und sogar neue Elemente, zugeordnet; vermöge dieser einen Eigenschaft hat man die Stoffe selbst „in Substanz" aus ihren Gemischen herausgezogen. Versucht man, die Forderung der Existenz von all diesen Bio-aktoren mit andern geschichtlichen Abläufen zu vergleichen, so wird man sie als eine Zwischenstufe ansehen: Die Wirkung eines körperlichen Gebildes wird in Bestandteilen zu isolieren versucht, von denen jeder auch für sich allein beständig sein soll. Es wird gelingen, den einen oder anderen dieser Stoffe wirklich weitgehend abzutrennen. Danach wird man seine Wirkung, da es sich hier nicht um Elemente handelt, auf die Gegenwart gewisser Atomgruppen in seinem Molekül zurückführen. So mag man zu „bioaktiven" Gruppen gelangen, wie man in der Chemie der Farbstoffe zu chromophoren und auxochromen Gruppen gekommen ist. An die Stelle des für sich isolierbaren Wirkungs-Stoffes tritt dann auch hier ein für sich unabtrennbarer Teil des Stoffes in die Rolle des Wirkungsträgers ein. Das ist bisher die einzige Form, in der wir uns von den Eigenschafts-Stoffen befreien können.

Auch in der Fermentforschung untersuchen wir Stoffe, die wir nicht kennen, von denen wir in bezug auf ihre stoffliche Natur nur wissen, mit welchen bekannten Stoffen sie nicht gleich sind. Wir erfahren zunächst von ihrer hervorragendsten besonderen Eigenschaft, bestimmte Reaktionen in besonderer Weise zu beeinflussen oder herbeizuführen. Damit aus diesen wirkenden Ursachen Stoffe werden, bemühen wir uns, diejenigen andern Eigenschaften aufzufinden, welche ihnen als Stoffen ausserdem noch zukommen müssen. Dem steht die andere Auffassung gegenüber, dass es nur Unterschiede im Zustand, in der Form, nicht im Stoff seien, von denen diese Wirkungen abhängen. Wenn damit nur mechanisch verschiedene Zustände gemeint sind, so sehen wir den alten Gedanken wiederkehren, wonach alle qualitative chemische Eigenart auf die physikalische Form der Materie zurückzuführen ist. Wenn aber die Besonderheit des Zustandes der Fermente mit ihrer Abstammung aus lebendigen Organismen

in Zusammenhang gebracht wird, so erscheint die alte Lebenskraft wieder.

Man könnte hier einwenden, dass es sich um recht allgemeine Gedanken handelt, die aus alter Zeit das Fundament auch der neuen Theorien bilden. Aber auch dies nachzuweisen ist nicht überflüssig, und dass solche alten Gedanken reichen neuen Inhalt dazu erworben haben, dass soll nicht geleugnet, sondern betont werden. Ausserdem möchte ich aber noch an einem recht speziellen Beispiel ein in mancher Hinsicht überraschendes Wiederaufleben eines alten Gedankens in einer hervorragenden neuen Theorie in einigen Zügen aufzeichnen.

6. *Theorie der Verbrennung*

Kohlenoxyd, CO, verbrennt an Platinkontakten mit Sauerstoff zu Kohlendioxyd, CO^2. Diese Reaktion scheint in ihrem Chemismus sehr einfach zu sein. Sauerstoff, das bekannte Oxydationsmittel, hat es hier besonders einfach : es braucht sich nur atomar anzulagern. Aber in Wirklichkeit geht es hier ganz anders zu: Wasser, wenn auch nur in sehr kleinen Mengen, muss zugegen sein, damit die Umwandlung eintritt. Das liegt, wie weitere Versuche zeigten, daran, dass zuerst Kohlenoxyd und Wasser zu dem Zwischenprodukt HCOOH, Ameisensäure zusammentreten. Aus der Ameisensäure werden die beiden Wasserstoffatome abgespalten. Diese Dehydrierung ist die zweite Stufe der Reaktion. Sie erst ermöglicht die Kohlendioxydbildung, während der Wasserstoff, und nicht das Kohlenoxyd mit dem Sauerstoff reagiert. So ist die ganze Umwandlung auch nicht eine Oxydation des Kohlenoxyds, sondern eine Dehydrierung seines Hydrates.

Auch Aldehyd (z.B. Formaldehyd, HCOH) verbrennt nicht direkt oder überhaupt mit Sauerstoff zur Säure; sondern sein Hydrat gibt Wasserstoff her, den der Sauerstoff abfängt. Dabei entsteht primär Wasserstoffsuperoxyd, dessen Auftreten bei Oxydationen seit SCHÖNBEIN von MORITZ TRAUBE, ENGLER und in neuester Zeit besonders von HEINRICH WIELAND bei den mannigfaltigsten Reaktionen festgestellt wurde. HEINRICH WIELAND verdankt man auch die zusammenfassende Theorie dafür, welche ganz allgemein die Dehydrierung an die Stelle der alten Auffassung der direkten Oxydation setzt.

Noch älter allerdings als diese Oxydationstheorie ist die Lehre vom Phlogiston. Sie lässt sich für die Reaktion, zu deren Erklärung sie beinah in der Hauptsache zu dienen hatte, durch folgende Gleichung kennzeichnen :

Metall minus Phlogiston gibt Metallkalk.

Die Bildung des „Zinkkalks" lässt sich nach TRAUBES Untersuchungen nur durch folgende Primärreaktion erklären :

Zinkhydrat minus Wasserstoff gibt Zinkoxyd.

Soweit sich Phlogiston mit einem Stoffe identifizieren lässt, ist es identisch mit Wasserstoff. Dann sind aber die beiden Reaktionsgleichungen, die alte und die neueste, einander gleich—bis auf das Wasser.

7. *Wasserstoff und Sauerstoff*

Der Antagonismus zwischen Wasserstoff und Sauerstoff hat noch auf einem ganz andern Gebiete Bedeutung. Bei LAVOISIER sollte der Sauerstoff derjenige Bestandteil sein, der den Säurecharakter veranlasste. Aber bei den Halogenwasserstoffsäuren, deren Konstitutionsaufklärung recht schwer darunter litt, dass man die neue Meinung vom Sauerstoff als dem säuernden Prinzip nicht aufgeben wollte, erkannte schliesslich HUMPHRY DAVY, dass der Wasserstoff die saure Natur brachte. BERZELIUS hielt der Wasserstofftheorie der Säuren entgegen, dass danach die Schwefelsäure, in der heutigen Form geschrieben, als $H_2 + SO_4$ aufgefasst werden müsste, und dass man danach die unerfüllbare Forderung zu stellen berechtigt wäre, das Säureradikal SO_4 als isolierte Substanz darzustellen. Die Ionisationstheorie löste diese Schwierigkeit. Aber die Konstitution der Säuren war damit noch nicht befriedigend geklärt. ALFRED WERNER nahm das Wasser, das als Dissoziationsmittel wirkt, in der Weise in die chemische Formel mit auf, dass er beispielsweise für Salzsäure schrieb : $Cl(H_2O)H$. Dies fand durch ARTHUR HANTZSCH eine wesentliche Korrektur, denn er zeigte, dass zuerst und allgemein der Wasserstoff der Säuren sich mit Wasser verbindet. Nach dem Schema : $Cl\text{-}H_3O$ sind die Säuren in wässriger Lösung konstituiert (7).

(7) *Ber. d. Chem. Ges.* 58 (1925), S. 612.

8. *Grenzen*

Was beweist dies alles, dieses Wiederaufleben und Wiederkehren alter Gedanken in neuen Theorien? Sind die alten Gedanken besser gewesen als unsere neuen, müssen wir die Produktivität früherer Zeiten nicht nur bewundern, sondern auch kraftlos beneiden? Ein Kantianer wird hier den auf einem Sondergebiet geführten Beweis für seine allgemeine Überzeugung sehen, dass unsre Erkenntnis durch das Wirken a priorischer Vernunftgesetze zustande kommt. Der Anhänger MACHS wird sagen, dass wir hier das Gesetz von der Denkökonomie wieder einmal vorfinden. Wir brauchen diese philosophischen Fragen nicht jetzt zu entscheiden. Ein wenig unbehaglich ist uns vielleicht bei dem Begriff der Denkökonomie zumute; sollten die experimentierenden Wissenschaftler, die so ungeheuer produktiv bei ihren Versuchsanstellungen sind, bei ihren Gedanken nur nach Sparsamkeit streben? Und über das a priori müsste man sich wohl noch in manchen Einzelheiten zu verständigen suchen. So begnügen wir uns mit der empirischen Feststellung, dass es von grossen umfassenden Gedanken überhaupt nur wenige gibt.

Es gibt vor allem auch solche, die nicht auf die Wirklichkeit passen, wie wir sie jetzt sehen. So haben auch viele von den alten Gedanken k e i n e Fortsetzung in neuen Theorien gefunden: z.B. die alte Lehre von den vier oder fünf allgemeinen Elementen, trotzdem sie noch von SCHELLING und HEGEL ganz und gründlichst philosophisch begründet worden ist. Wärmestoff und Lichtmaterie, die in den chemischen Systemen des frühen neunzehnten Jahrhunderts noch gleichberechtigt, in gewisser Hinsicht bevorrechtet neben den andern Elementen stehen, sind weiterhin aus diesem Zusammenhange gestrichen und durch Energiearten ersetzt worden. Wenn heute ein stoffliches Äquivalent der Energiemenge genau bestimmt werden konnte, so ist damit jene alte Vorstellung in ihrem damaligen Sinne nicht gerettet; denn ihr Wiedererstehen hätte nicht darin sich ausgedrückt, dass man jedem Körper bei der Energieaussendung einen Verlust an seiner Materie zuspricht, sondern nur darin, dass man gesagt hätte, dieser Stoffverlust bestünde bei allen verschiedenartigen Körpern immer aus einer und derselben Art von Materie. Dagegen unterscheiden sich die Vorläufer unsrer

Affinitätstheorien von den heutigen zum Teil nur dadurch, dass die Begriffe Masse und Intensität nicht richtig eingesetzt wurden, wie bei BERTHOLLET.

Bei alledem ist noch eins zu bedenken. Der Gedankengehalt der Chemie beschränkt sich nicht auf den ihrer Theorien. Auch in den Experimenten steckt viel, und ganz besonders viel Gedankengut. Es ist der grosse Vorzug der Chemie als experimenteller Wissenschaft, dass sie uns nicht nur Worte als Mittel für den Ausdruck unsrer Gedanken gewährt.

9. *Chemische Theorien und philosophische Systeme.*

Das Verhältnis zwischen alten Gedanken und neuen chemischen Theorien würde erst dadurch ganz geklärt werden können, dass man die Einflüsse nach beiden Richtungen hin verfolgt : die Benutzung der alten Gedanken bei der Theorie für chemische Befunde, und umgekehrt den Einfluss von Erfahrungen und Theorien der Chemie auf die philosophische Gedankenarbeit. Vielleicht ist dieser zweite Teil der schwieriger zu erforschende. In der älteren Zeit, als der Alchemist noch Philosoph und der Philosoph oft ein wenig Alchemist war, mag die Beeinflussung des einen durch den andern noch leichter aufzuweisen sein, als für spätere Zeiten. SPINOZA fand sein philosophisches System stark angerührt durch BOYLES Untersuchungen über den Salpeter, und BOYLE konnte mit einigen einfachen Versuchen Beiträge zur Philosophie der Materie liefern. Aber dann wurde anscheinend die Chemie allmählich so kompliziert und spezialisiert, dass ihr Einfluss auf die Philosophie sich verringerte. Während Mathematik und Physik ihren Platz in den Systemen vieler Philosophen stets beibehielten, beginnt erst in unseren Tagen die Chemie wieder Beachtung bei den Philosophen zu finden. Als Beitrag zu einer Geschichte des Einflusses der Chemie auf die neuere Philosophie mag daher eine kleine Sammlung von kurzen Auszügen aus philosophischen Systemen des 17.-19. Jahrhunderts hier folgen, um Material und Anregung für ihre weitere Bearbeitung zu bieten. Solche Bearbeitung würde dann auch verlangen, dass man biographisch verfolgte, was der eine und der andere Philosoph von Ergebnissen der Chemie so aufnahm, dass es beim Aufbau seines Weltbildes gestaltend mitwirkte.

JOHN LOCKE (1632-1704)

ERNST CASSIRER zeigt, dass bei Locke die Chemie eine wichtige Rolle spielt (8). Die Art der chemischen Eigenschaftsforschung gilt ihm als vollkommenes Beispiel unserer naturwissenschaftlichen Erkenntnisfähigkeit. „Wenn wir noch so viele Merkmale des Goldes, seine Dehnbarkeit, seine Härte, seine Feuerbeständigkeit usf. zusammenstellen, so können wir doch von ihnen aus keine einzige n e u e Bestimmung entdecken, so können wir niemals die Form der Verknüpfung v e r s t e h e n, kraft deren bestimmten Merkmalen der einen Art stets bestimmte andere einer anderen Art entsprechen. Eine derartige Einsicht... wäre nur dann möglich, wenn wir, statt lediglich Beobachtungen über das empirische Beisammen oder die empirische Unverträglichkeit von Merkmalen zu sammeln,... von irgendeiner Wesensbestimmung des Goldes ausgehen könnten, um aus ihr die Gesamtheit der sekundären Eigenschaften deduktiv abzuleiten" (9).

Das hatten chemische Philosophen schon vor LOCKE erkannt. Der Unterschied besteht darin, dass diese Vorgänger, ebenso wie ihre späteren Nachfolger zur Blütezeit der „Naturphilosophie", ungeduldig ein Wortwissen vom Wesen der Dinge konstruierten, während LOCKE die tatsächlichen Schranken konstatiert. Führt dies auch nicht über den erreichten Stand der Kenntnisse hinaus, so nimmt es doch von ihm das abschätzige Urteil, unzulänglich zu sein, indem es das Erreichte philosophisch als das Erreichbare wertet.

GOTTFRIED WILHELM LEIBNIZ (1646-1716)

Allem Leben liegen einfache Formen zugrunde : die selbständigen und nur durch die prästabilierte Harmonie miteinander verbundenen M o n a d e n. Sie haben mit physikalischen Atomen nichts zu tun. LEIBNIZ ist ein Gegner der Atomenlehre. Er verwirft die Atome als Fiktionen, wie man sie dann aufstellt, wenn man sich nicht mehr zu helfen weiss; man käme ebenso weit, wenn man das Geschehen direkt, also ohne solche Umwege,

(8) „Substanzbegriff und Funktionsbegriff", Berlin, 1923.

(9) LOCKE, „Essay on human understanding", Buch 4, Kapitel 6, nach CASSIRER, *l. c.*, S. 290.

als Wunder bezeichnen würde. Was man wirklich beobachtet, stellt man als eine „okkulte Eigenschaft" noch einmal hinter die Erscheinungen, indem man z.B. die Härte aus einer „dureté primitive" der Atome herzuleiten versucht. Diese Kritik erinnert sehr lebhaft and die Darlegungen L. T. MORE's in seiner Schrift : „The Limitations of Science" (New York, 1915). Die reichlich zweihundert Jahre, die dazwischen liegen, haben zwar eine gewaltige Entwicklung der Atomistik gebracht, aber anscheinend die LEIBNIZsche Haltung dazu nicht unmöglich gemacht.

Aber LEIBNIZ verwirft nur solche zur Metaphysik missbrauchten Gedankendinge; einen Mechanismus hält er für sehr geeignet, wahre Erklärungen zu finden. Auch für ihn besteht die Materie aus Teilen, die in Bewegung sind, und deren Bewegungen miteinander verbunden und aufeinander abgestimmt sind : „des mouvements qui s'accordent". Der Atomistiker HARTSOEKER, mit dem LEIBNIZ über diese Dinge korrespondiert (10), hat es leichter, die Metallverwandlungen aus einem Grundgedanken als unmöglich abzuleiten : Die Atome, die ewig und homogen sind, haben für Gold andere Grösse und Gestalt, als für Silber oder Wasser. LEIBNIZ kann darauf etwas weniger bestimmt, aber gerade heute sehr beziehungsreich erwidern : Wenn wir genügend feine Augen hätten, um in die Stoffe hineinzusehen, dann würden sich uns auch darin kleine Teilchen zeigen, die sich reiben und brechen, und es gibt da keine unendliche Festigkeit. „Aber immerhin ist das System der Dinge gut genug ausgeformt, um bestimmte Einzeldinge getrennt zu erhalten und nicht leicht gewisse Zerstörungen zu gestatten, die wir ja nur mit unsern groben Mitteln veranstalten könnten und die nicht auf die feinsten inneren Spalten (fissures) einzuwirken vermögen" (11). Dieser Gedanke, dass es auf das Verhältnis der Feinheiten bei dem einwirkenden Mittel und der damit untersuchten Materie ankommt, kehrt in neuster Zeit in den Überlegungen VON LAUE's wieder, der die Kristalle mit derjenigen Strahlenart durchleuchtete, deren Wellenlänge im geeigneten Verhältnis zu den Gitterabständen steht. Nur ist es hier, wie in manchen ähnlichen Fällen, fraglich, ob

(10) „Die philosophischen Schriften von G. W. LEIBNIZ", hg. von C. I. GERHARDT, Band 3, Berlin, 1887, insbesondere S. 499 ff.

(11) *L. c.*, S. 500.

ein historischer Zusammenhang besteht, ja auch nur, ob der alte Gedanke die neuen Untersuchungen hätte befruchten können.

Die Chemie wird in all diesen LEIBNIZschen Gedankengängen nur insoweit berührt, als die Probleme der Teilbarkeit und der Bewegung der Materie auch zu ihr gehören. Die qualitative Verschiedenheit der Stoffe erscheint in diesen Äusserungen nur ganz allgemein als eine von der universellen Harmonie geordnete. Tiefer in die Probleme der Chemie und ihre allgemeine Bedeutung wäre er geführt worden, wenn er seine Forderung nach einer „scientia generalis de qualitate", entsprechend der Algebra als der Wissenschaft von der Quantität, selbst zu erfüllen versucht hätte.

DAVID HUME (1711-1776)

In der „Inquiry concerning human understanding" (1748) beschäftigt sich HUME in den ersten Abschnitten mit den Qualitäten. Seine Darlegungen beziehen sich zwar nicht ausdrücklich auf die Chemie; dennoch konnten sie wohl auch für manchen Chemiker Anregungen bringen. HUME benutzt als Beispiel das Brot. Wir beurteilen es nach seinen äusseren Eigenschaften, wie sie direkt wahrnehmbar sind, z.B. Farbe und Konsistenz. Wo diese äusseren Eigenschaften bei verschiedenen Stücken gleich sind, schliessen wir, dass auch die inneren Eigenschaften, also die Nährkraft des Brotes, gleich sein werden. Damit vollziehen wir einen besonderen Schritt, der zu erklären ist. Er beruht auf einem seelischen Prozess, „der ebenso unabweisbar ist, wie das Gefühl der Liebe... oder des Hasses" (12). Das Problem des Verhältnisses zwischen inneren und äusseren Eigenschaften hätte auch an den damaligen Erfahrungen der Chemie recht fruchtbar untersucht werden können; in Wirklichkeit blieb aber die Diskussion rein philosophisch-metaphysisch. Früher einmal, zur Zeit von ROBERT BOYLE's Untersuchungen über die Natur des Salpeters (1659), hatte der Philosoph SPINOZA die allgemeine Bedeutung der Ergebnisse nicht nur philosophisch diskutiert, sondern auch durch eigene Experimente weiter zu erklären sich bemüht. Dieses einzigartige Beispiel fand wenig

(12) „Enquiry" deutsche Ausgabe bei RECLAM, S. 45, 61.

Nachfolge. Vielleicht kann man das sonderbare Werk des Bischofs GEORGE BERKELEY (1685-1753) : „Siris, a chain of philosophical reflexions and inquiries concerning the virtues of tar-water..." (London, 1744/8) hierher zählen : Von einer Erörterung der Heilkraft des Teerwassers gelangt BERKELEY zu den Prinzipien der Natur und Gottes Wesen.

IMMANUEL KANT (1724-1804)

KANT lehrte nicht nur Philosophie; er las, besonders in jüngeren Jahren, mit Vorliebe Anthropologie und Geographie. Nicht nur der Kategorische Imperativ und die Frage : „Wie sind synthetische Urteile a priori möglich?" sind mit seinem Namen verknüpft, sondern auch die einzige umfassende Theorie vom Wesen der Gestirne, die noch heute wissenschaftlich lebendig ist. Gerade weil sich KANT so stark mit Naturwissenschaften befasste, ist es erstaunlich, wie wenig die Chemie für ihn bedeutete. Vielleicht hängt dies damit zusammen, dass ihn das „Prinzip des Mechanismus" zu immer wiederholten Auseinandersetzungen reizte, sowie mit dem Schluss, zu dem er in der „Kritik der Urteilskraft" kam : „Die Befugnis, auf eine bloss mechanische Erklärungsart aller Naturprodukte auszugehen, ist an sich ganz unbeschränkt" (13). Bei seiner umfassenden Bildung ist ihm die Chemie nicht etwa in Einzelheiten unbekannt; er erwähnt z.B. in der Vorrede zur „Kritik der reinen Vernunft" (2. Ausgabe, 1787), wie „STAHL Metalle in Kalke und diese wiederum in Metalle verwandelte, indem er ihnen etwas entzog und wiedergab.." Ja, „dieses Experiment der reinen Vernunft", nämlich aus Annahmen über ihre Funktion die Folgerungen zu ziehen, „hat mit dem der Chemiker, welches sie manchmal den Versuch der Reduktion, im allgemeinen aber das synthetische Verfahren nennen, viel Ähnliches". Als Beispiel für Vernunftbegriffe, die „nicht aus der Natur geschöpft" sind, führt er auch die reinen Elemente der Chemie an, natürlich die alten : Erde, Salz und brennliche Wesen, Wasser und Luft. Man trifft diese Elemente in der Natur nicht rein an, sie haben also in

(13) S. 417, Akademieausgabe.

unserer Vernunft ihren Ursprung, wir „befragen die Natur nach diesen Ideen..." (14).

So sind KANT Ergebnisse der Chemie und ihre Begriffe wohl gegenwärtig; schon in einer seiner frühesten Abhandlungen, über „Die Frage, ob die Erde veralte, physikalisch erwogen" (1754), ist einer der Gründe für die Bejahung der aufgestellten Frage, dass eine „flüchtige Säure, die allenthalben in der Luft ausgebreitet ist, die das aktive Prinzipium in den meisten Arten der Salze, der wesentliche Teil des Schwefels und der vornehmste in dem Brennbaren des Feuers ausmacht" (15), allmählich verbraucht wird. Wenn er den synthetischen Aufbau des Erfahrungsbildes aus der „Affinität des Mannigfaltigen" unserer Beobachtungen zustandekommen lässt, so gab der chemische Sinn des Wortes Affinität seinen ganzen Beziehungsreichtum zur Erklärung hinzu. Doch kann man nicht sagen, dass die Chemie irgendeine bedeutende Stellung im philosophischen Weltbild KANT seinnahm, oder dass ihm Tatsachen und Gedanken der Chemie so dringlich der Diskussion würdig und bedürftig schienen, wie diejenigen aus Mathematik und Physik. Wohl benutzt er gelegentlich ein veranschaulichendes Beispiel, wie wenn er sagt : „Die systematische Einheit der Verstandeserkenntnisse" ist „der Probierstein der Wahrheit der Regeln" (16). Solcher bloss bildliche Gebrauch hat aber mit dem Weltbilde des Philosophen wenig zu tun; er hätte ebenso gut, nur weniger anschaulich, auch „das Kriterium der Wahrheit" sagen können.

Noch ein anderes solches Beispiel sei angeführt, weil es den Naturforscher KANT kennzeichnet : Er spricht von den Definitionen und sagt von ihnen, dass sie der Mathematik angehören, nicht der Philosophie. "Und wozu sollte es auch dienen, einen solchen Begriff zu definieren, da, wenn z.B. von dem Wasser und dessen Eigenschaften die Rede ist, man sich bei dem nicht anfhalten wird, was man bei dem Worte Wasser denkt, sondern zu Versuchen schreitet, und das Wort, mit den wenigen Merkmalen, die ihm anhängen, nur eine B e z e i c h n u n g und nicht einen Begriff der Sache ausmachen soll..." (17). Dies klingt wie

(14) Kritik der reinen Vernunft, S. 673. (Orig. Ausg. A).
(15) S. 212.
(16) Kritik der reinen Vernunft, S. 647, i. Ausg. 1781.
(17) Ebenda S. 727 f.

eine Warnung an die Naturphilosophen; sie haben sich wenig darum gekümmert.

Jakob Friedrich Fries (1773-1843)

Als Nachfolger und Fortbilder von Kants Philosophie steht Fries auch in seinen Gedanken zur Chemie im Gegensatz zu den Naturphilosophen von Schellings Art. Bei Schelling (1775-1854) spukt noch das „menstruum universale" aus alchemistischer Zeit, nun verfeinert, verallgemeinert, umgewandelt zu Äther oder Weltseele. Die Materie wird verachtet, sie ist nicht das eigentlich „Daseyende", sondern die Kraft ; er sieht die Natur „nicht mechanisch, sondern dynamisch" an. In der zweiten Auflage seines grossen Werkes „Neue Kritik der Vernunft" sagt Fries gegen diese Schellingsche Ansicht : „Hier versteht er den Unterschied des Mechanischen und Dynamischen nicht, indem er ihn dem des Lebendigen und Todten gleichsetzt. Es war der Fehler der Atomenlehre in engster Bedeutung als einer nur mechanischen Physik, dass sie das Wesen der Materie ohne alle Kraft, ohne alle Dynamik zu verstehen hoffte, dagegen fordert die Dynamische Ansicht vor allem Kraftäusserung durch ursprüngliche Anziehung und Abstossung von der Materie. Aber diese Kraftäusserung ist noch nicht Leben in imminenterem Sinne, dieses Anziehen und Abstossen ist eine durchaus äussere Reaktion des einen gegen das andere, Leben aber ist nur da, wo innere Tätigkeit ist, unmittelbar in der Materie also nirgends" (18).

Man verdankt Fries so klare und nicht nur damals notwendige Einsichten wie die folgende : „Wir müssen die Unvollendbarkeit der mathematischen Reihen für die Naturbeobachtung als Gesetz stehen lassen, und dürfen nie hoffen, sie durch Voraussetzungen aus der Idee theoretisch zu ergänzen, indem dies in der Natur baarer Widerspruch wäre. Wir werden also erstlich nicht zugeben, dass man die unvollendbare endliche Realität des Geistes in der inneren Erfahrung durch die Unsterblichkeit der Seele nach der Idee ergänze, sondern wir bleiben für die Natur nur bey ihren Gesetzen des Endlichen " (19).

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(18) 2. Aufl. Heidelberg, 1831, 2. Band. S. 328.
(19) Ebenda S. 330 f.

Aber nur gelegentlich der Polemik gegen SCHELLING geht FRIES auf chemische Dinge ein. Er übernimmt von KANT und SCHELLING den „Begriff einer vollständigen chemischen Durchdringung. Durch das aneignende Oxygen in der Verkalkung wird z.B. das Silber der Salzsäure verbunden, so dass nun ein durchaus homogenes salzsaures Silber bis in seine kleinsten Theile gegeben ist, in welchem kein Theil weder Oxygen, noch Silber, noch Salzsäure ist, sondern jeder die chemische Vereinigung dieser drey" (20). Die Chemiker meinten es anders; aber selbst ein so klar zwischen Wirklichkeitserkenntnis und Spekulation unterscheidender Philosoph wie FRIES leitet eine Aussage über chemische Konstitution aus seinem Begriff von Verbindung ab. Hier wie an einigen Stellen, wo er Beispiele aus der Chemie zur Belebung des Textes gebraucht, kann man vielleicht ersehen, welche chemischen Dinge damals wissenschaftliches Allgemeingut geworden waren, aber im philosophischen Weltbilde bedeuten sie wenig. Ähnlich wie KANT will auch FRIES „alle anfänglich erscheinenden empirischen Qualitäten der äusseren Empfindung... in lauter Gesetze der Bewegung auflösen" (21). Aber dieses Programm ist zu weit und der zeitgenössischen naturwissenschaftlichen Erfahrung zu fern. „... für Qualitäten aber gibt es ja überhaupt keine Theorie..." (22). Damit erübrigte sich das Eingehen auf die Chemie für den Philosophen.

GEORG WILHELM FRIEDRICH HEGEL (1770-1831)

FRIES lehnt SCHELLINGS Philosophie ab, weil sie die Verhältnisse von Erscheinung und An-sich-Sein, von materieller und geistiger Ansicht der Dinge falsch darstelle. HEGELS Naturphilosophie hat im wesentlichen ähnliche Grundlagen wie diejenige SCHELLINGS, besonders in den Ideen über Materie und Stoffe. Unter Benutzung dieser wesentlichen Vorarbeit gelangt HEGEL vielleicht als erster und einziger unter den Philosophen der neueren Zeit dazu, dem Chemismus im Weltprozess seine eigene Stellung einzuräumen.

Dabei ist für HEGEL noch im Jahre 1827, als er seine

(20) Ebenda S. 323.
(21) Ebenda S. 159.
(22) Ebenda S. 213.

umgearbeitete zweite Auflage der „Enzyklopädie" herausgab, die Phlogistik die Grundtheorie der Chemie, und seine Elementenlehre knüpft wesentlich an diejenige des ARISTOTELES an. Das hängt vielleicht mit seiner Unzufriedenheit mit den zeitgenössischen Chemikern zusammen, denen er den Vorwurf macht, metaphysische Abstraktionen und leere Allgemeinheiten aufzustellen (23). Es erscheint ihm als eine „sinnliche Spielerei", so viele neue Elemente aufzustellen, statt auf die wahren Grundstoffe zurückzugehen. Diese Grundstoffe sind die wahren physikalischen Elemente, nämlich :

1. Die Luft, „das Element der unterschiedslosen Einfachheit";
2. Das Feuer, „die materialisierte Zeit";
3. Das Wasser, das Element der Neutralität;
4. Die Erdigkeit, das Element des eigentlichen, „entwickelten" Unterschieds.

An sich sind die Stoffe „neutral", sie treten in Spannung zueinander, und der chemische Prozess hat das Ziel, diese Spannung aufzuheben. „Der chemische Prozess hat daher das N e u t r a l e seiner gespannten Extreme, welches diese a n s i c h sind, zum Produkte" (24). Führt man „das begeistende Prinzip der Differenzierung" wieder ein, so trennt man das Neutrale wieder. So kann die Spannung der verschiedenen Metalle gegeneinander das neutrale Wasser in seine Extreme : Sauerstoff und Wasserstoff zerlegen, wobei diese allerdings auch als die Produkte der Tätigkeit des Wassers aufzufassen seien. Der Übergang des elektrischen in den chemischen Prozess wird von HEGEL mit eingehender Polemik gegen BERZELIUS in einen konkreten und einen abstrakten Prozess zerlegt. Der vollständig reale chemische Prozess liegt vor, wenn sich neutrale Körper unter dem Einfluss der Wahlverwandtschaft miteinander verbinden, während die Vereinigung von Säure und Base zum Neutralen nur die Umkehrung eines Teilprozesses, des Feuerprozesses bedeutet.

In der Mechanik werden die Objekte als selbständige Dinge betrachtet; dieser Auffassung widerspricht es, dass die Stoffe in

(23) „Enzyklopädie", Philos. Bibl. Leipzig, Band 33, S. 295.
(24) Ebenda, S. 183.

chemische Beziehungen zueinander treten und selbst Produkte von Umwandlungsprozessen sind. An die Stelle der Selbständigkeit, vom mechanistischen Standpunkt aus gesehen, tritt also im Chemismus die Bezogenheit der Objekte aufeinander, wodurch jene Selbständigkeit negiert wird. Das im chemischen Prozess sich zeigende Streben zu einem Endzustande enthält schon etwas von dem Zweckbegriff, der im organischen Leben so starke Bedeutung gewinnt. Daran erkennt man die Stufe, auf der der Chemismus unter den Tätigkeiten des Weltgeistes steht.

Wenn man die Frage stellt, wie sich solche Darlegungen, wie diejenigen in HEGELS System über die Chemie, zu unsern heutigen chemischen Einsichten verhalten, so darf man vergleichsweise daran erinnern, welche Bedeutung andere Teile dieses Systems gewonnen haben und noch besitzen. Diese Frage geht also über dasjenige, was nur geschichtlich aufschlussreich ist, hinaus auf die dauernde sachliche Bereicherung, die auch heute von Wert sein müsste. Dies Wertvolle sind nicht seine Ansichten über Galvanismus, Metallität oder Elemente; das sind auch nicht manche wohlberechtigte Kritiken an den zeitgenössischen Äusserungen philosophierender Chemiker und Mediziner; aber es ist die Einordnung des Chemismus zwischen Mechanismus und Organismus in das Stufenreich der Erscheinungsformen und Tätigkeiten des Geistes (25).

ARTHUR SCHOPENHAUER (1788-1860)

In einem Briefe an FRAUENSTÄDT (12. 10. 1852) sagt SCHOPENHAUER, dass man Naturwissenschaften studiert haben muss, um über den „Gipfel der gesamten Naturwissenschaft", die Physiologie, mitreden zu dürfen, und das habe er getan, da er unter anderem dreimal Chemie auf der Universität gehört habe. Aber aus dem, was er da zu hören bekam, ist in seinen philosophischen Schriften hauptsächlich die oft wiederholte Ablehnung des anmassenden Theoretisierens der Chemiker geworden. Den Physikern mit der „unglaublichen Rohheit" ihrer Erklärungsweisen ist es allerdings ähnlich ergangen. Am deutlichsten kommt dies in den „Parerga und Paralipomena" (1851) zum Ausdruck :

(25) Vgl. E. FÄRBER, „HEGELS Philosophie der Chemie" in „Kant-Studien" 30, S. 91 (1925).

§ 76. ... Sie meynen, ihr physikalischer oder chemischer Apparat solle statt ihrer denken und solle selbst, in der Sprache blosser Experimente, die Wahrheit aussagen. Zu diesem Zwecke werden nun die Experimente ins Unendliche gehäuft und in denselben wieder die Bedingungen; so dass mit lauter höchst komplicirten, ja endlich mit ganz vertrackten Experimenten operirt wird, also mit solchen, die nimmermehr ein reines und entschiedenes Resultat liefern können,...

§ 77. ... Die chemischen Atome sind bloss der Ausdruck der beständigen festen Verhältnisse, in denen die Stoffe sich mit einander verbinden, welchem Ausdruck, da er in Zahlen gegeben werden musste, man eine beliebig angenommene Einheit, das Gewicht des Quantums Oxygen, mit dem sich jeder Stoff verbindet, zum Grunde gelegt hat : für diese Gewichtsverhältnisse hat man aber, höchst unglücklicher Weise, den alten Ausdruck A t o m gewählt; und hieraus ist unter den Händen der französischen Chemiker, die ihre Chemie, s o n s t a b e r n i c h t s g e l e r n t haben, eine krasse Atomistik erwachsen, welche die Sache als E r n s t nimmt, jene blossen Rechenpfennige als wirkliche Atome hypostasirt und nun von der Zusammenstellung (arrangement) derselben in einem Körper so, im Andern anders, ganz in DEMOKRITS Weise redet, um daraus deren Qualitäten und Verschiedenheiten zu erklären; ohne irgend eine Ahndung von der Absurdität der Sache zu haben. Dass es in Deutschland nicht an unwissenden Apothekern fehlt, die auch „das Katheder zieren" und jenen nachtreten, versteht sich von selbst, und darf es uns nicht wundern, wenn sie in Kompendien, geradezu dogmatisch und ganz ernsthaft, als wüssten sie wirklich etwas davon, den Studenten vortragen „d i e K r i s t a l l f o r m d e r K ö r p e r h a b e i h r e n G r u n d i n e i n e r g e r a d l i n i g e n A n o r d n u n g d e r A t o m e"...

„... Bei der erwähnten Zurückführung der chemischen Verbindungen auf sehr feine Atomengemenge findet freilich die Manie und fixe Idee der Franzosen, Alles auf m e c h a n i s c h e Hergänge zurückzuführen, ihre Rechnung; aber nicht die Wahrheit, in deren Interesse ich vielmehr an den Ausspruch OKEN's (über Licht und Wärme p. 9) erinnere, „dass nichts,

durchaus nichts im Universum, was ein Weltphänomen ist, durch mechanische Prinzipien vermittelt sei"... »

Im Rahmen seines Hauptwerkes, worin ähnlich gegen Atomistiker und die „elektrischen, chemischen und mechanischen Physiologen" (26) argumentiert wird, heisst es einmal : „Ebenso lehrt uns die C h e m i e , wie sich der Wille benimmt, wenn die inneren Qualitäten der Stoffe... freies Spiel erhalten..." (27).

Im übrigen wird seine Stellung zur zeitgenössischen Naturwissenschaft ebenso wie seine grosse Bescheidenheit dadurch gekennzeichnet, dass er selbst in einem späteren Briefe an FRAUENSTÄDT die Proportion aufstellt : HELMHOLTZ verhält sich zu SCHOPENHAUER wie ein Maulwurfshaufen zum Mont Blanc (15. 7. 1855).

10. *Chemische Analogien in der philosophischen Psychologie des 19. Jahrhunderts*

In der Psychologie, einem Teilgebiet der Philosophie des 19. Jahrhunderts, spielt die Benützung chemischer Grundbegriffe bei einzelnen Denkern eine so grosse Rolle, wie auf keinem anderen philosophischen Gebiet. Es ist nicht schwer, darin etwas anderes als einen Zufall zu erkennen. Ehe wir dies untersuchen, betrachten wir einige solcher Äusserungen.

FRIEDRICH EDUARD BENEKE gab im Jahre 1822 ein später oft wieder benutztes Buch heraus : „Grundlegung zur Physik der Sitten, ein Gegenstück zu Kants Grundlegung der Metaphysik der Sitten mit einem Anhang über das Wesen und die Erkenntnisgrenzen der Vernunft". Hier, wie in dem 11 Jahre später veröffentlichen „Lehrbuch der Psychologie als Naturwissenschaft" sucht er den psychischen Erscheinungen dadurch auf den Grund zu kommen, dass er sie in elementare Vorgänge zerlegt. Er setzt sie in Analogie zu den chemischen Elementen, indem er von dorther die Begriffe Anziehung und Verbindung übernimmt. In gewisser Hinsicht gab es dafür schon mancherlei Vorarbeit. Man denke z.B. an SHAKESPEARE's „Cäsar" 5. Akt, 5. Aufzug (1601) :

(26) „Die Welt als Wille und Vorstellung," Bd. 1, S. 201 (Ausg. RECLAM).
(27) Ebenda, Bd. 2, S. 348.

His life was gentle; and the elements
So mix'd in him, that Nature might stand up
And say to all the world, " This was a man ! "

Noch weiter als BENEKE ging HERBERT SPENCER (1820-1903). Er brachte noch eine Anwendung des Atombegriffs in die Psychologie. Wie die Materie von materiellen Atomen, sei die geistige Substanz von den psychischen Atomen gebildet, die sich nach besonderen Gesetzen assoziieren (28). HUGO MÜNSTERBERG (1863-1916) erörterte die Frage, welches denn die psychischen Atome seien, und er weist darauf hin, dass die Empfindungen ihrerseits noch in einfachere Bausteine, eben die Atome, zerlegt werden können. WILHELM WUNDT (1832-1920) betonte (29) allerdings, dass die Analogie zwischen den psychischen und den physischen Atomen nicht weit führt. „Nicht die Zerlegung der Materie in Atome, sondern eher die Zerlegung einer Bewegung in Komponenten oder in die momentanen Geschwindigkeiten eines bewegten Punktes entspricht auf dem Gebiete der Physik den psychischen Elementarbegriffen". Während er das Suchen nach psychischen Elementen für eine wichtige Aufgabe hält, erklärt JOHANNES REHMKE (30), dass alle solche Elemente nur unbrauchbare Kunstprodukte (Artefakte) seien.

Vielleicht würde es bei diesen Diskussionen förderlich gewesen sein, wenn man klarer auseinander gehalten hätte, was nach der chemischen Analogie einerseits unter Atomen, andererseits unter Elementen verstanden werden muss.

Ansätze zu einer „Chemie der Seele", die von manchen Seiten lebhaft begrüsst wurden, enthält GUSTAV JÄGER's Lehre von den Geruchsstoffen, die jedem Individuum und seinen seelischen Zuständen eigen sein sollen. Dies führte wenigstens zu einem praktischen Ergebnis, nämlich den weltbekannten Jäger-Hemden, durch die eine allzu grosse Ausdünstung der Seelenstoffe verhindert werden sollte. Eine „Vergleichende Psychologie auf chemischer Grundlage" aufzubauen, versuchte JAQUES LOEB in seinen „Vorlesungen über die Dynamik der Lebenserscheinungen" (1906).

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(28) O. KLEMM, Geschichte der Psychologie, Leipzig, 1911, S. 108.
(29) Grundzüge der physiologischen Psychologie, Bd. 1, S. 417 (6. Aufl., 1908).
(30) Allgemeine Psychologie, (1904).

Zusammenfassung

Manche Philosophen haben in ihrem Lehrgebäude eine kurze Betrachtung allgemeiner Tatsachen der Chemie eingefügt, um die angestrebte systematische Vollständigkeit herzustellen. Nicht das ist es, was wir suchen, wenn wir nach der Bedeutung der Chemie im philosophischen Weltbild fragen. Andere haben aus ihrem vorher fertigen philosophischen Gedanken der Chemie vorgeschrieben, zu welchen Ergebnissen sie kommen müsse. Auch da beeinflusst die Chemie nicht die Philosophie, vielmehr wird eine umgekehrte Richtung beabsichtigt. Die Chemie hat solche Einwirkungsversuche in der neueren Zeit nie sehr ernst genommen.

Gross ist die Zahl von philosophisch fundierten Voraussagen auf chemische Entdeckungen. Man kann sie hinterher ausgraben und gelegentlich auch feststellen, dass einige dieser Ahnungen in gewissem, nie in vollem Umfang zu den späteren Befunden passen. Kaum je wird man aber finden können, dass die Voraussage das spätere Forschungsergebnis hat herbeiführen helfen. Immerhin zeigen solche Fälle manchmal eine bemerkenswerte gedankliche Leistung und bestätigen, dass die Philosophie, wie es FRIES gelegentlich sagte, ein Arsenal der naturwissenschaftlichen Möglichkeiten darstellen kann.

In dieser Hinsicht ist ein Büchlein interessant, das von J. W. RITTER im Jahre 1810 herausgegeben wurde : „Fragmente aus dem Nachlass eines jungen Physikers. Ein Taschenbuch für Freunde der Natur" (31) Ich zitiere daraus einige Sätze, solche, die uns ganz abwegig erscheinen müssen, neben anderen, die in überraschender Weise verwirklicht wurden : Band 1, S. 34 : „Alle Stoffe auf Erden scheinen zerlegtes Eisen zu sein. Eisen ist der Kern der Erde, „der sichtbare Quellgeist der Erde" (JAC. BÖHME)".

S. 84 : „Es gibt nur einen Körper, der der festen Gestalt fähig ist, das Wasser. Alle Körper sind nur durch das Eis in ihnen fest".

S. 161 : „Sollte es magnetische, elektrische Telescope geben

(31) Heidelberg, bey MOHR u. ZIMMER. Ich verdanke Herrn Dr. W. PAGEL den Hinweis auf diese Schrift.

können? Spiegel für Magnetismus, Elektrizität? Linsen, Telescope und Spiegel für alle Kräfte? In welcher Ordnung mögen wohl die Körper die Elektrizität, den Magnetismus, brechen?"

S. 169 : „Gibt's in HERRSCHEL's Spektrum ausserhalb oder über die warmen und oxydierenden Strahlen hinaus nichts weiter? und eben so auf der anderen Seite des Spektrums über die desoxydierenden Strahlen hinaus?"

2. Band S. 25 : (im Zusammenhang mit „Bemerkungen zu BRANDIS, Versuch über die Lebenskraft, 1795") : „Da KANT Wasserzersetzung als Vehikel der Seelentätigkeit vorschlägt, und es fast bewiesen ist, dass im Wasser die beiden Grundkräfte, welche das Lebensprinzip konstituieren, im gleichsam ruhenden Zustand liegen, so wäre es wohl möglich, und im Grunde dem Sinn der Kantischen Hypothese ganz gleichstimmend, dass das Ich bei seiner Tätigkeit zunächst auf diese Kraft (die Wasserzersetzung), in und mit ihr wirkte".

S. 27 : „Sind wohl Miasmen, Pockengift u.s.w., eine Art von organischem, organisch sich fortpflanzendem Stoff, etwa in Parallele zu stellen mit den parasytischen Pflanzen?"

S. 36 : „Das Individuum ist die Wiederholung des Ganzen; — Die physische Geschichte des Individuums wird die physische Geschichte des Ganzen..."

S. 185 : „Der Wendepunkt der Schöpfung war der des Eintritts der Oxydation. Das Leben ist Cultus, das Leben ist Oxydation, folglich Oxydation = Cultus. Athmen wird religiöser Akt. Des Menschen Athmen ist sein Leben, die Art seiner Gottesverehrung".

S. 208 : „Niemand ist so leicht in Gefahr, Taschenspieler zu werden, als ein Chemiker, der seine eigene Theorie hat".

Es ist merkwürdig um solche Ahnungen bestellt, insofern als sie sehr selten direkt als Anregungen gewirkt haben. Vielleicht liegt es daran, dass der Weg von soweit vorgreifenden Gedanken zur naturwissenschaftlichen Prüfung sehr schwer gangbar ist. Fast immer sind daher die Ergebnisse, die auf solche alten Gedanken als Erklärung zurückführen, aus ganz unvorhersehbaren Zusammenhängen erwachsen.

Auch dies also, diese empfindsame Vorausahnung chemischer Gesetzmässigkeiten durch den Philosophen, entsprach nicht dem, was uns als lebendiger Einfluss der Chemie auf das Weltbild

eines Philosophen vorschwebte. Ein grosses Beispiel gibt es für solchen Einfluss, und es betrifft einen Philosophen, der ebenso sehr Dichter und Naturforscher war : GOETHE. Ihm sind die Gesetzmässigkeiten der Wahlverwandtschaften in ihrer Beziehung auf das menschliche Leben zu einem grossen Gleichnis geworden. Nicht ein unfassbares Schicksal, sondern ein auf einer anderen Stufe, in den Beziehungen zwischen verschiedenen Stoffen, in seiner Wurzel erkennbares Gesetz herrscht über den beiden Paaren, die sich in seinem Roman „Die Wahlverwandtschaften" begegnen. Mit welch überlegener Klarheit schildert er (Ende des 4. Kapitels) dieses Gesetz von der chemischen Seite her ! Möglicherweise war diese klare Einsicht vielen Philosophen versagt. Diese Vermutung wird bestärkt, wenn man selbst bei WILHELM WUNDT gelegentlich findet, dass er allgemeine chemische Beziehungen falsch darstellt : „Im Gegensatz zu den physikalischen Körpern haben die psychischen Prozesse die Eigentümlichkeit an sich, dass die zusammengesetzten psychischen Gebilde im Verhältnis zu den Elementen neue Eigenschaften aufweisen, die sich nicht voraussagen lassen. Dieses Prinzip der schöpferischen Synthese..."(32) Auch chemische Verbindungen haben meist ganz neue Eigenschaften im Vergleich zu ihren Elementen !

Heidelberg. EDUARD FÄRBER.

(32) Logik. 3. Aufl., Band 3, S. 274.

Further notes on the Arabic alchemical manuscripts in the libraries of India

The readers of *Isis* are well acquainted with the fundamental investigations on Arabic alchemy carried out by Dr. HENRY E. STAPLETON, late principal of Presidency College in Calcutta, or under his direction. Their publication began more than thirty years ago, and the collection of the papers which appeared over his signature in 1905, 1910, 1927, 1933 (to mention only the most important) is one of our most valuable sources for the study of that very recondite subject. Dr. STAPLETON's works have often been reviewed or quoted in our journal; it will suffice to refer the reader to my review of " Chemistry in Iraq and Persia in the tenth century " (Calcutta, 1927; *Isis* 11, 129-34) and to JULIUS RUSKA's elaborate discussion of " Three Arabic treatises on alchemy by MUḤAMMAD IBN UMAIL " (Calcutta, 1933; *Isis* 24, 310-42).

In recent years Dr. STAPLETON has begun a search for alchemical MSS in the treasure houses of India, and his first—tantalizing—account of this new venture appeared in 1932 " Note on the Arabic MSS on alchemy in the Âṣâfîyah Library, Hyderâbâd " (*Archeion*, 14, 57-61; *Isis* 19, 431). During his return journey from India he did me the honor of writing me a letter containing an account of his latest investigations which I found so interesting and stimulating that I was anxious to share it with the *Isis* community. He kindly allowed me to do so and I take great pleasure in publishing it below.

The letter, written on board the Dutch ship " Christiaan Huygens " (a very appropriate ship for a historian of science !) is dated " Bay of Biscay, S. W. of Ouessant. April 19th 1936." G. S.

" Dear Dr. SARTON, This letter will be posted in Southampton and apart from being a very belated acknowledgment of your two letters of 35.10.20 and 35.11.10 is only to give you some idea of what I have been able to do during the past winter in the way of tracing alchemical Mss. in the libraries of India.

" I arrived at Colombo on Nov. 1st, and after delivering a couple of lectures before the University of Madras on the history

of Bengal (in amplification of my article in the last *Kern Institute Annual Report*), I reached Hyderābād on Nov. 9th. I found the new assistant, I had secured through the good services of a Professor of the Osmaniyah University, had been able to go through nearly the whole of the 62 volumes of alchemical treatises in Arabic that are found in the Āṣafīyah Library—apart from the 26 volumes of Persian treatises, 3 Urdu ones and 4 printed (modern) works in Arabic, which he had not had time, or inclination, to deal with. I therefore thought it best to concentrate on getting out a nominal list of the different treatises contained in all the 95 volumes (with a brief summary now and then of their contents, when the treatise seemed more than normally interesting), and this I was just able to complete before I went on to Calcutta at Christmas. The number of treatises (or considerable extracts from treatises) in Arabic was found to have risen from under 200 to over 300 though, of course, there are a great number of duplicates. I was also able to start re-investigating the treatises and alchemical views of KHĀLID IBN YAZĪD, as, after coming across a 15-line extract from a poem, apparently, addressed to his cousin YAZĪD II IBN 'ABDAL MALIK at (or after) the time of the latter's accession to the throne in 720 A.D. and discovering the amount of information about KHĀLID that is available in the pages of AṬ-ṬABARĪ and the *Kitāb al-aghānī*, I realized that the treatises in the Rāmpur Library that AZO and I dealt with years ago are probably quite authentic and not forgeries after all.

" In Calcutta I remained about six weeks, working in the rooms of the Asiatic Society of Bengal, chiefly on a précis of the alchemical Mss. in the British Museum (as these were mostly drawn from India), but also amplifying my notes on the Hyderābād Mss. from the printed catalogues of Mss. in Europe, as hardly any catalogues are available in Hyderābād. Another difficulty about work in Indian libraries is illustrated by the fact that though I had been assured that there were only 2 or 3 alchemical Mss. in the A.S.B. collection, I discovered quite accidentally, just before I had to go on to Patna and Rāmpur, that there were no less than 10 of them (both Arabic and Persian) in the library. They are, however, not of much interest, except for the *Kitāb 'ilal* of BALĪNĀS, and 3 (?) copies of AR-RĀZĪ's *Sirr al-asrār*.

" From Calcutta, I went on to Patna, to see how the cataloguing

of the Khuda Bakhsh library at Bankipore was getting on, as well as to collect more information about the small number of alchemical Mss. that I knew they had. Only 3 of AL-JILDAKĪ's works were included in the Ms. of vol. XXII that was about to be sent to the press : but my visit will probably lead to the contents of at least one *Majmu'* of 5 alchemical treatises being added—the latter including two by IBN SĪNĀ : and a search the Maulvi in charge has promised to make may result in more being found.

" My next stop was at Rāmpur : and as the catalogue of the alchemical Mss. there (which had been partially made about 3 years ago by a research student I sent for the purpose from Calcutta, but then mislaid) had been at last retrieved, I had a busy 10 days making a précis of the 34 (out of the 45) volumes labelled *Kīmiyā*, which contain treatises in Arabic.

" The best *Majmu'* (no. XVII) is the one described in the Mem. A.S.B. many years ago. There is also another copy of a long alchemical treatise of Qāḍī Sayyid 'ABD AL-JABBĀR AL-HAMADĀNĪ, who died after 479 A.H.-1086 A.D., and who was a pupil of one MUḤAMMAD IBN 'ABDALLĀH AL-BUZMAJĀNĪ, which had been noted at Hyderābād; but, beyond this, the only two that may be of some interest to you are : (1) copy of a Risālah on Kīmiyā of ARISTOTLE for ALEXANDER, which is stated to have been translated from Greek into Syriac by YAZDĪN, the Christian Wazīr of Kisrā (? Khusraw Parvīz, 590 to 627 A.D.) in the 930th year of ALEXANDER (? 607 A.D.) and translated from Syriac into Arabic for AL-MANṢŪR (754-775 A.D.).

" (2) *Adh-dhakhīrat al-Iskandarīyah*, said to have been written by HERMES, and discovered by BALĪNĀS. The latter gave it to ARISTOTLE (!), who dedicated it to ALEXANDER. It was then engraved on thick plates of gold, which were placed in a chest of gold enclosed in another chest and concealed in the wall of a church at ' Amurīyah. Here it was discovered when AL-MU'TASIM (who died in 841 A.D.) captured the town, and it was then translated from Greek into Arabic. The story is perhaps given some verisimilitude by the discovery of the inscribed gold plates, in 3 languages, of XERXES, recently found at Persepolis. Another copy of this treatise is in the A.S.B. library.

" On my way back to Hyderābād, viā Delhi and Bhopāl, I

ascertained that no alchemical Mss. appear to be available in either of the two likely libraries in Delhi, or in the larger one at Bhopāl.

" During my all too brief return visit of less than 3 weeks to Hyderābād, I chiefly occupied myself with the new material provided in the first volume of Dr. KRAUS' *Jābir*. In particular, his extract from the *Kitāb ar-rāhib* completes the chain of information I had been gathering about KHĀLID and it is now clear :

(1) that KHĀLID (who was born in 672 A.D.) derived some of his alchemical knowledge from a monk called MARIYĀNOS (Mss. in Āṣaf. lib. Hyderābād).

(2) AṬ-ṬABARI, the *Kitāb al-aghānī* and the *Fihrist*—all agree that KHĀLID was interested in alchemy. He himself also claims in the poem to YAZĪD previously referred to, to have succeeded in its practice.

(3) KHĀLID was the first to cause alchemical works (in Greek and Coptic) to be translated into Arabic by some Greek philosophers living in Cairo *(Fihrist)*.

(4) KHĀLID probably survived until at least 720 A.D. and lived in Damascus (*vide* poem already mentioned).

(5) JĀBIR, whose alchemical master was HARBĪ, the Donkey-Eared Logician, also learnt from another monk, who is said in the *Kitāb ar-rāhib* to have been a pupil of MARIYĀNOS, the teacher of KHĀLID.

(6) that the Imām JA'FAR AṢ-ṢĀDIQ (through his being a cousin, by marriage, of KHĀLID) was almost certainly acquainted with KHĀLID's alchemical writings, and, if so, probably utilised this knowledge as an additional ' background ' to his Imāmate.

(7) that (as I previously mentioned to you in some letter) JĀBIR appears to have been the private (Court) alchemist of JA'FAR AṢ-ṢĀDIQ, and certainly wrote under his direction *(vide* prefaces to various of JĀBIR's treatises).

" Finally, at the beginning of what is possibly an authentic copy of the actual *Kitāb ar-Raḥmah* of JABĪR (in the Āṣafīyah library, and which I hope to induce Dr. KRAUS to edit) it is stated that this treatise was found under JĀBIR's pillow, when he died in 200 A.H. (815 A.D.) in Ṭūs. This is valuable not only in giving a date for JĀBIR's death, but also in explaining why JĀBIR is referred to as aṭ-Ṭūsī—not because he was born there, but

because he took refuge in this place when the Barmecides were extirpated by HĀRŪN. Incidentally too, it confirms AL-JILDAKĪ's statement (quoted in HOLMYARD's first paper on JĀBIR) that JĀBIR survived till the days of the Caliph AL-MA'MŪN, who succeeded to the throne in 813.

" I am afraid all this may rather upset Dr. RUSKA's previous ideas (1); but facts are facts, and if for nothing else but the clearing up of the details of the transference of the alchemical knowledge current in pre-Islamic times in Alexandria (and Northern Mesopotamia) to the Arabs through KHĀLID and JĀBIR, my exploratory trip to India will have been amply justified.

" The more I think, however, of the amount of work that has still to be done, the more idiotic I feel at ever having ventured to begin this enquiry at all. A professional Arabic scholar is needed—not an amateur with half a dozen other interests. As, however, I promised Prof. BIDEZ to compile a catalogue of the Arabic MSS. on Alchemy in India, I suppose I must try to complete the task; but Dr. KRAUS is the obvious man to tackle the masses of new material for the early history of alchemy that are constantly being found in these MSS., and, if he could be financed, I would most gladly hand over the entire business to him.

" Again thanking you for your two letters, and with my best salāms.

Yours sincerely,
H. E. STAPLETON."

(1) *Vide*, e.g. his CHĀLID IBN YAZĪD IBN MU'ĀWIJA (Heidelberg, 1924).

Notes on the history of anagrammatism(*)

The London *Times* of September 8, 1934 included the letter reproduced below :

A theological anagram. " The following Latin anagram may interest some of your readers. It is not, I think, inappropriate for your issue of September 8, on which day for about 15 centuries has been kept the Feast of the Birthday of the Blessed Virgin.

Ave Maria Gratia Plena Dominus Tecum

gives

Deipara Inventa Sum, Ergo Immaculata.

" I have not been able to trace the discoverer of this remarkable theological anagram. Could some mathematician calculate the odds against the 31 letters in the Latin version of the Angelic Salutation being found, when rearranged, to express both the doctrine of the sinlessness of the Mother of God (Deipara, *θεοτόκος* of the Council of Ephesus) and also the reason for this unique privilege? —Rev. Francis Woodwell, S.J."

This brought forth a few days later, September 13, the following answer :

" In response to Father Woodwell, may I say that during the sixteenth to eighteenth centuries many thousands of anagrams were formed from the Angelical Salutation, principally by members of religious orders, including not a few from members of Father Woodwell's own society?

" Space will forbid the mention of all the contributors to this form of literature, but in 1701 Ambrosius Nieszporkowitz, of the Hermits of St. Paul, published his *Fragmenta*, which contained upwards of 3,000 metrical anagrams on St. Luke i., 28, all asserting, directly or indirectly, the Immaculate Conception. In the same year Lucan de Vriese, a Belgian, in his *Metamorphosis Angelica*, produced 3,100 prose anagrams on the Angelical Salutation, and Christopher Klimmechius, in four volumes a further 2,830. At other times many other writers added to the number, and there were very few duplicates. This fact may be appreciated from the statement of Prester, in his *Éléments des Mathématiques*, that the name Ignatius can be changed in its letters no fewer than 40,320 times.

Dudley Wright."

The literature of anagrams was studied by the late Rev. Walter

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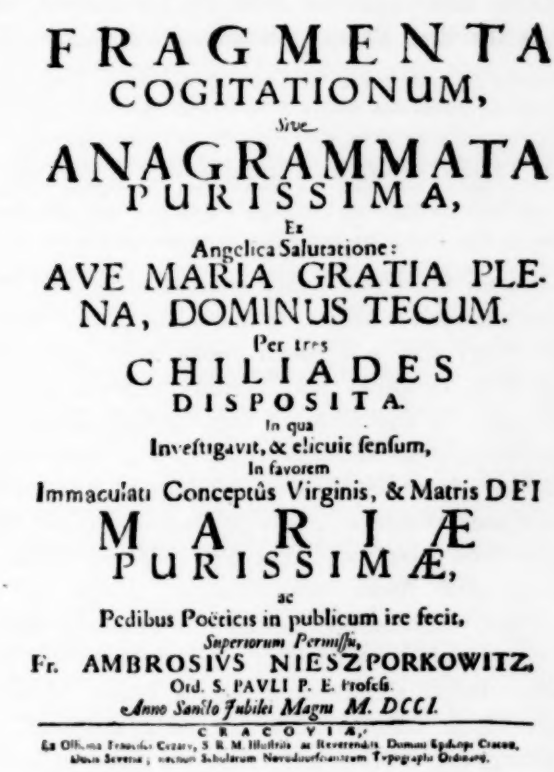
(*) Danda est remissio animis, meliores acrioresque requieti ut surgent (Seneca, *De tranquillitate animi*, XV).

BEGLEY (1845-1905), Vicar of East Hyde, Bedfordshire, who made a collection of such curiosities and devoted to them a book entitled *Biblia anagrammatica or The anagrammatic Bible* (viii + 212 p., Privately printed for the author, 1904), this being a sort of companion volume to his *Biblia cabalistica or The cabalistic Bible* (vii+158 p., London, 1903). He published other books of a similar



FRAGMENTA
COGITATIONUM,
Sive
ANAGRAMMATA
PURISSIMA,
Ex
Angelica Salutatione:
AVE MARIA GRATIA PLENA, DOMINUS TECUM.
Per tres
CHILIADES
DISPOSITA.
In qua
Inveſtigavit, & elicuit ſenſum,
In favorem
Immaculati Conceptûs Virginis, & Matris DEI
MARIÆ
PURISSIMÆ,
ac
Pedibus Poëticis in publicum ire fecit,
Superiorum Permiſſu,
Fr. AMBROSIVS NIESZPORKOWITZ,
Ord. S. PAVLI P. E. Profeſſ.
Anno Sanctо Jubilei Magni M. DCCI.
CRACOVIÆ,
Ex Officina Francisci Cezary, S. R. M. Illuſtriſs. ac Reverendiſs. Domini Epiſcopi Cracov.
Typis Severini, nec non Scholarum Norodoxorum Typographi Ordinarij.

FIG. 1.

kind entitled, e.g., *Is it* SHAKESPEARE? (400 p., London, 1903), BACON'S *Nova resuscitatio or the unveiling of his concealed works and travels* (3 vols., London, 1905), the volumes 2 and 3 of which bear the significant subtitles : *The exit of* SHAKSPERE; *Enter* BACON. The Harvard Library has bought his collection of Anagrams, including 36 volumes of MSS. and 1 envelope of MSS. on the subject (MS. Eng. 569-569.37), a manuscript Bibliography of anagrams in two volumes (MS. Eng. 569.38-39),

seven volumes of notebooks and commonplace books, and other MSS. Future students of that particular aberration of the human mind may well begin their investigations in our library.

The rarest book of the Rev. BEGLEY's collection is the *Fragmenta* of the Polish brother AMBROSIUS NIESZPORKOWITZ (ob. 1703) mentioned in Mr. WRIGHT's letter reproduced above. See my facsimile of the title page (the first word *Fragmenta* measures 16 cm.) Says the Rev. BEGLEY (*Biblia anagrammatica*, p. 205) :

" This book, the greatest *tour de force* of all the works mentioned in this Bibliography, is in my possession, and (as I learn from M. ESTREICHER, the famous Polish Bibliographer) is the only one known to him, and therefore probably unique. It contains 3000 *metrical* anagrams, hexameters and pentameters, on the Angelical Salutation, LUKE i. 28, all asserting the Immaculate Conception, either directly or indirectly (1), and bringing in, often very skilfully, the various titles and attributes given to the Virgin by ecclesiastical writers."

I have not seen the other books mentioned in Mr. WRIGHT's letter, but the authors are known to me. LUCAS DE VRIESE (Ypres 1640-Bruges 1723) was a Flemish monk who spent sixty-five years of his life in the abbey of the Dunes, expressing his intense religious devotion in the form of innumerable anagrams. See notice in the *Biographie nationale* (vol. 5, 874, Bruxelles, 1876). His main work " *Hortulus acrostice anagrammaticus marianus ter mille diversicolorum elogiorum*... was printed in Bruges 1700, and reprinted ten years later under the title *Metamorphosis angelica mariana in ter mille figuras transformata*. These two editions as well as a third undated one contain the same number of anagrams, viz. 3100, 100 acrostics of 31 anagrams each. The third man, CHRISTOPHORUS KLIMECCIUS, was a Polish Minorite who composed the *Messis liliorum quinaria ex horto mariano*... (Cracow 1688) containing 525 Biblical anagrams, the *Liber anagrammatum pro immaculato ortu beatissimae virginis*... (Zamosc, Poland, 1696), and other books of the same kind. I have quoted those champion anagrammatists for the sake of illustration; curious readers may find many more of them in the Rev. BEGLEY's erudite and genial catalogue.

Judging from that book and from the author's MS. notes, the anagrammatic mania seems to have been especially prevalent

(1) These words reveal the unnamed source of Mr. DUDLEY WRIGHT's letter (G. S.).

in Poland, but no country was ever completely free from it, and the anagrammatists, chronogrammatists, and other learned soothsayers, whose crankiness was only equalled in some cases by their prodigious industry, shared the prestige and favour of astrologers and alchemists. Thus we hear of one THOMAS BILLON who was the official anagrammatist to LOUIS XIII and received a pension of 1200 livres which was continued to his children (2).

That kind of mania is no longer in the fashion. It is possible that the anagrammatists of the golden age, that is, the end of the seventeenth century and beginning of the eighteenth, carried their art so high and accomplished such prodigies in it that it was hardly possible for their successors to equal them. Their astounding virtuosity discouraged emulation. However, this did not destroy the mania but simply obliged it to take another form. Budding anagrammatists have become acrosticians, and the cranks who spent their days trying to find more anagrams of the Angelic salutation, are now engaged in such pursuits as proving the Baconian authorship of SHAKESPEARE's plays by means of acrostic signatures. For example consider the books of the late WILLIAM STONE BOOTH (1864-) : *Some acrostic signatures of* FRANCIS BACON (Boston, 1909); *The hidden signatures of* FRANCESCO COLONNA *and* FRANCIS BACON. *A comparison of their methods* (Boston, 1910); *Marginal acrostics and other alphabetical devices, a catalogue* (Cambridge, 1920); *Subtle shining secrecies writ in the margents of books generally ascribed to* WILLIAM SHAKESPEARE, *the actor and here ascribed to* WILLIAM SHAKESPEARE, *the poet* (Boston, 1925).

Chronogrammatic, anagrammatic, or acrostical " proofs " are very impressive for uneducated people or even for highly educated ones, like Father WOODWELL, who are not acquainted with combinatorial analysis and whose mind is obsessed with irrational tendencies. If one realizes that the permutations of n objects number $n!$ (i.e., the product of all integers from 1 to n; a large number even if n is relatively small), then it follows that a word or phrase including n letters must have $(n! - 1)$ anagrams. If one has enough patience to collect them, it will then suffice to keep and publish the desirable ones and throw out those which are not.

(2) After REMY DE GOURMONT's witty article on anagrams in the *Grande Encyclopédie.*

In his *Budget of paradoxes*, AUGUSTUS DE MORGAN tells us that a friend of his had made 800 anagrams on his (DE MORGAN's) name, two of which have been joined on the title page of that volume (1872, p. 82; D. E. SMITH's edition, 1915, 1, 138). It must be admitted however that those anagrams are not particularly striking or felicitous. DE MORGAN was not a good anagrammatic subject!

The history of anagrammatism is a part of the history of superstition, but it sometimes concerns the historian of science. Not only in a general way, as truth is not always sharply separated from error, nor reason from unreason, but also because anagrams were occasionally used by men of science who desired to announce a discovery and establish their priority without running the risk of being plagiarized by unscrupulous rivals. In the seventeenth century the anagram served the same function as the "plis cachetés" which are still in use to-day in academies, notably in the French academy of sciences. The most famous example of a "protective" anagram is the one by means of which CHRISTIAAN HUYGENS announced his discovery of the ring of Saturn in a small pamphlet *De Saturni luna observatio nova* (The Hague, 1656). He revealed the anagrammatic secret three years later in his *Systema Saturnium* (The Hague, 1659). See below the facsimiles of the title page of that famous work and of the relevant page (p. 47). For more information on the subject one could not do better than to consult vol. XV of HUYGENS' works (The Hague, 1925), admirably edited by J. A. VOLLGRAFF (*Isis* 21, 213-5).

It should be noted that the "protective" use of the anagram was just the opposite of the "prophetic" use. Anagrammatists are like fortune tellers using cards to interrogate Providence; HUYGENS on the contrary was writing correct answers letter by letter on cards and then shuffling these deliberately in order that he might publish the truth without revealing it. This may help us to realize in another way the endlessness of anagrammatic ambiguities. HUYGENS knew that he was safe enough. He needed sixty two letters to write his secret, and these would form 62! permutations or about 3146×10^{82} anagrams. The probability of finding the right formula among these was smaller than that of finding the proverbial needle in an immense haystack.

CRISTIANI HVGENII
ZVLICHEMII, CONST. F.

SYSTEMA SATVRNIVM,

SIVE

De cauſis mirandorum SATVRNI Phænomenôn,

Et

Comite ejus

PLANETA NOVO

HAGÆ-COMITIS,

Ex Typographia ADRIANI VLACQ,
M. DC. LIX.

FIG. 2.

ea quam dixi annuli inclinatione, omnes mirabiles Saturni facies ſicut mox demonſtrabitur, eo referri poſſe inveni. Et hæc ea ipſa hypotheſis eſt quam anno 1656 die 25 Martij permixtis literis una cum obſervatione Saturniæ Lunæ edidimus.

Erant enim Literæ aaaaaaaccccceddeeeeegh iiiiiiiiillmmnnnnnnnnnoooopprrssttttuuuuu; quæ ſuis locis repoſitæ hoc ſignificant, *Annulo cingitur, tenui, plano, nuſquam cohærente, ad ecliptican inclinato.* Latitudinem vero ſpatij inter annulum globumque Saturni interjecti, æquare ipſius annuli latitudinem vel excedere etiam, figura Saturni ab aliis obſervata, certiuſque deinde quæ mihi ipſi conſpecta fuit, edocuit: maximamque item annuli diametrum eam circiter rationem habere ad diametrum Saturni quæ eſt 9 ad 4. Ut vera proinde forma ſit ejuſmodi qualem appoſito ſchemate adumbravimus.

Cæterum obiter hic iis reſpondendum cenſeo, quibus novum nimis ac fortaſſe abſonum videbitur, quod non tantum alicui cæleſtium corporum figuram ejuſmodi tribuam, cui ſimilis in nullo hactenus eorum deprehenſa eſt, cum contra pro certo creditum fuerit, ac veluti naturali ratione conſtitutum, ſolam iis ſphæricam convenire, ſed & quod annulum

Occurrit quæ de annulo objici poſſent.

FIG. 3.

Another famous scientific anagram was introduced twenty years later than HUYGENS' by no less a person than NEWTON. In the latter's very long letter of Oct. 24, 1676 to the Secretary of the Royal Society, HENRY OLDENBURG, he concealed anagrammatically his discovery of the infinitesimal calculus. The original letter extending over 14 folio pages is in the British Museum. It was first published in the *Opera mathematica* of JOHN WALLIS (vol. 3, 634-45, Oxford, 1699), and may be found also in the various editions of the *Commercium epistolicum* (1712, 1722, 1725, 1856) (3).

The NEWTON anagram was relative to a matter more fundamental, and vastly more important than the HUYGENS one, but it was less famous as it was not immediately printed and for almost a quarter of a century could only be known to a very small inner circle of mathematicians. However, NEWTON's letter of 1676 to the Secretary of the Royal Society was less a private letter than a publication, unprinted yet formal. It was really meant for LEIBNIZ (4). Later NEWTON corrected it, and OLDENBURG delayed sending a copy of the corrected letter to LEIBNIZ until May 2, 1677 (after J. EDLESTON : *Correspondence of Sir* ISAAC NEWTON, 1850, p. lii).

To return to the old anagrammatic delusion, no sane man would attempt to " prove " a religious dogma by such means, because this would imply the ascription of an absolute and universal value to the accidental spelling of an individual language; no sane man would attempt to " prove " a scientific statement by a felicitous permutation any more than by a happy throw of dice or a grand slam. The " protective " use of anagrams was not itself irreproachable, but must be considered with leniency, considering the evils of those days. At any rate it involved no lies and no fallacies.

GEORGE SARTON.

(3) There are really two anagrams in that letter. See WALLIS, p. 636, 645, or *Comm. ep.*, ed. BIOT, p. 128, 144. Those interested in the anagrams only will find them more conveniently in L. T. MORE's excellent biography of NEWTON (1934, 190).

(4) WALLIS (3, 624). " *Epistola* D. NEWTONI *posterior, ad* D. OLDENBURGIUM, Oct. 24ª 1676. *cum* D. LEIBNITIO *communicanda.*"

Carnegie Institution of Washington. Division of historical research. Section of the history of science.

Eighteenth annual report for the period extending from July 1, 1935 *to June* 30, 1936 *(Previous reports appeared in* Year Books *of the Carnegie Institution, no.* 18 *to* 34, 1919 *to* 1936; *the* 12*th and following also appeared in* Isis, *the latest in vol.* 24, 422-428, 1936).

1. *Introduction to the History of Science.*—The preparation of volume III on " Science and learning in the fourteenth century " is proceeding slowly, far too slowly. The amount of material to be collected, analyzed, and combined is far superior to whatever had been anticipated. However, the slowness is caused less by the size and complexity of the work than by the increasing number of interruptions, due to the growing interest of all kinds of people in the history of science. The Jewish part of volume III is thus far the only large part to be completed; that is, all the individual notes are practically finished, but according to SARTON's method the synthesis must be postponed until *all* the notes relative to every aspect of the subject are completely ready; the analytical stage of the work must be perfected in every possible direction before the synthesis can be begun.

Dr. WELBORN has continued the revision and amplification of the Latin notes.

Dr. ALEXANDER POGO devoted the period under review to study of astronomical problems involved in the correlation of Maya and Christian chronologies. His report follows :

2. *Maya astronomy.*—It is, occasionally, difficult to decide whether a lunar eclipse should be considered as umbral or as penumbral. Thus, OPPOLZER's *Canon der Finsternisse* lists a small

partial eclipse occurring 1890 June 3; the *American Ephemeris and Nautical Almanac* predicted a lunar appulse for that date, adding, however, the following remark: "The nearness of the approach and the uncertainty as to the effect of the earth's atmosphere render it doubtful whether the moon will enter the shadow of the earth or not." The small partial lunar eclipse of 348 October 23.96 could be quoted, on the other hand, as an example of an eclipse not listed in the *Canon*; OPPOLZER's computations indicated that the eclipse was penumbral, and it was, therefore, not included in the *Canon*; a more elaborate computation, made with the aid of NEUGEBAUER's tables, shows that the moon unquestionably entered the umbra, and that the partial phase ended at sunset, as far as eastern Yucatan is concerned, or before sunset for the rest of the Maya territory.

Lunar saros series	1st group at "picture" intervals	Lunar saros series	2nd group at "picture" intervals	"Picture" numbers	Intervals in days
L141	521 Dec 29.5	L100	554 Sep 27.1	X	
					502
L158	523 May 15.4	L117	556 Feb 11.4	I	
					1743
L217	528 Feb 21.3	L176	560 Nov 19.0	II	
					1033
L 29	530 Dec 20.4	L211	563 Sep 18.0	III	
					1211
L 70	534 Apr 14.4	L 29	567 Jan 11.2	IV	
					1742
L129	539 Jan 20.3	L 88	571 Oct 18.9	V	
					1034
L164	541 Nov 19.5	L123	574 Aug 18.3	VI	
					1211
L205	545 Mar 14.5	L164	577 Dec 11.2	VII	
					1565
L 35	549 Jne 25.9	L217	582 Mar 25.2	VIII	
					1210
L 76	552 Oct 18.5	L 35	585 Jul 17.5	IX	
					709
L100	554 Sep 27.1	L 59	587 Jne 25.9	X	
					11960

The ecliptic nature of the pentamenos and hexamenos count preserved in glyph C of the Supplementary Series is obvious; the Maya must have known that it is easier to determine the beginnings of these periods not directly, by waiting for the infrequent eclipses of the new moon visible in their territory, but indirectly, by subtracting 15 days from the dates of the

frequently observed eclipsed full moon. The compilers of the table of ecliptic syzygies preserved in the Dresden Codex knew that five of six lunations after an observed lunar eclipse, another lunar eclipse was likely to be visible in the Maya territory. Since the darkening of the limb of the moon, when its approach to the umbra is sufficiently close, differs but little from the darkening of the limb during a small partial eclipse, and since the Maya priests were unable to compute the magnitude of an eclipse, or to distinguish, on theoretical grounds, between umbral and penumbral eclipses of the moon, it is reasonable to assume that their records of observed lunar eclipses included both small partial eclipses and close appulses. It must be kept in mind that a celestial phenomenon may be too inconspicuous to attract the attention of an indifferent layman glancing at the sky, while it may be sufficiently noticeable to be recorded as observed by an astronomer who was expecting its occurrence.

No study of the lunar calendar of the Maya and of their table of ecliptic syzygies can, therefore, be complete, unless both umbral and penumbral eclipses are taken into consideration. For this reason, a special canon of penumbral lunar eclipses which might have been visible in the Maya territory was computed with the aid of NEUGEBAUER's tables; it covers the two millennia preceding the arrival of the Spaniards. By combining the data of this special canon with OPPOLZER's data, the number of Mec groups at " picture " intervals (see the previous report) was increased from 17 to 27; the ten additional groups include from one to four appulses each. The problem of deriving a correlation from these groups, by eliminating spurious solutions, became more complex; on the other hand, the addition of the " picture " groups containing appulses simplified the study of the periodicity of these groups, thus throwing additional light into the dark past whence the Mec emerged. Like the Julian and the Gregorian calendar years with seven eclipses, mentioned in the bibliography appended to this report, Mec groups at " picture " intervals form patterns showing a tendency to congregate in certain centuries and to avoid others. This gives, incidentally, a terminus ante quem for the original Maya ecliptic table, a copy of which was included in the collection of astronomical tables known as the Dresden Codex; no group of ten lunar eclipses at " picture " intervals could have

been observed in the Maya territory after the middle of the Xth century of the Christian era. The most promising centuries, from the point of view of a correlation based on the pages 51 to 58 of the Dresden Codex, are the Vth and the VIth (10 groups), and the second half of the VIIIth and the first half of the IXth centuries (4 groups).

The table on p. 140 illustrates the cyclical nature of the Mec groups at " picture " intervals; the last eclipse of the first group is the first eclipse of the second group.

3. *Other investigations.*—Dr. SARTON conducted various archaeological investigations relative to pre-Hellenic science in Crete, Egypt and India.

He made a preliminary survey of the methods which may facilitate later the historical study of twentieth century science. The problem to be solved is this one : " If the growth of science continues at the present rate, will it remain possible for any historian, however deep his scientific preparation, to understand and record further progress? And will the historian of, say, the twenty-first century be able to write the scientific history of our times? How will he manage to do it? Can we not take steps from now on to facilitate his task or simply to make it possible? " He conducted some correspondence on the subject with the president and other members of the Institution. He will offer his conclusions in the form of a presidential address to section L of the A.A.A.S. at its next meeting (Atlantic City, December 1936).

He continued his study of Arabic and of Arabic science, thus laying a solid foundation for his survey of Arabic science and learning in the fourteenth century to be completed next year for vol. III of the Introduction.

Dr. WELBORN completed a study of deontological traditions in the medical literature of the fourteenth century.

4. *Editing of Isis and Osiris.*—During the year 1935-6, four numbers of *Isis* were published (66 to 69) forming the whole of volume 24, and halves of volume 23 and 25 respectively, a total of 1247 pages, 6 plates, 32 figures and facsimiles. These four numbers contain 34 memoirs, 49 shorter items, 79 reviews and 2675 bibliographic notes.

It had long been felt that the publication of long articles (say, articles of more than 20 pages) was jeopardizing the main purpose of *Isis*, which is to promote the history and philosophy of science as a new discipline, to illustrate on the one hand its wholeness and its complex interrelations and on the other hand as many special aspects of it as possible. It is clear that this cannot be properly done if too much space is devoted to any single topic, however interesting that topic may be. Therefore it has been necessary to establish a new serial, named *Osiris* (a name illustrating its intimate connection with *Isis*) wherein the longer memoirs will appear as well as collections of articles relative to a single subject. The first volume of *Osiris* was published in January 1936 to celebrate the jubilee of Professor DAVID EUGENE SMITH, historian of mathematics, founder of the *History of Science Society*, and one of the pioneers of the history of science movement in America. It is a volume of 778 p. (same size and style as *Isis*), with 22 plates, 35 facsimiles and 24 figures, containing 38 studies relative most of them to the history of mathematics. It may be confidently expected that the publication of *Osiris* will improve the variety and interest of *Isis*.

The publications of *Isis* and *Osiris* being added, amounted to 2025 pages, with 28 plates and 91 figures and facsimiles, containing 72 memoirs, 49 shorter items, 79 reviews and 2675 bibliographic notes.

5. *Center of research in the history of science and learning.*—The remarks made in the previous report would apply equally well to the present period but it is unnecessary to repeat them. However, it is worth while to emphasize that the continual increase of books and documents, as well as the continual increase in their use by more and more people create difficulties which are becoming perilous. The question arises: Will the activities of this center of research be allowed a normal growth or will they be smothered and stopped? It should be noted that the present stage of affairs is not by any means a climax but only a modest beginning.

6. *Lectures.*—Dr. SARTON gave a course of about 35 lectures on the History of Mathematics at Harvard University and at

Radcliffe College, and directed a Seminary on the History of Science at Harvard University (*Isis* 26, 154). In addition he delivered a lecture on " Arabic science and mediaeval culture " at the annual meeting of the Mediaeval Academy of America, in Boston, April 25; and other lectures before the History Reference Council in Boston, the Star Chamber of Dunster House and the Cambridge Chapters of Gamma Alpha and Sigma Chi, the Massachusetts Psychiatric Society, the anthropological seminary of Harvard University. On May 23, he spoke on MAIMONIDES at the Harvard Philosophy Club (*Isis* 24, 120); on December 10 he delivered the Elihu Root lecture in Washington on „ The history of science and the problems of to-day "; on January 31, he discussed „ Humanism vs. grammar " at the annual dinner of the American Council of Learned Societies in Washington (*Isis* 25, 6-8).

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Notes and Correspondence

Answer to Query n° 53.—Standing on the shoulders of giants (*Isis* 24, 107-9, 1935).

I have just come across your query concerning BERNARD OF CHARTRES' image of the dwarfs sitting on the shoulders of giants. I am very grateful to you that you have drawn my attention to the passage in NEWTON's letter which I did not know, and I have much pleasure in enclosing a number of ' testimonia ' (1) to the simile which I have collected for my edition of the works of both BERNARD and THIERRY OF CHARTRES, which will appear in the course of this winter.

I have no doubt that PETER OF BLOIS as well as NECKAM go back, indirectly, to BERNARD OF CHARTRES, though they do not mention any name. The former, most likely, knew the quotation through JOHN OF SALISBURY, as well as the other Latin authors who make use of it. The same may be the case with the Hebrew writer who is the source of AZARJAH DE ROSSI.

OTTO OF FREISING's characteristic conception of a 'progress' to be found in world-history, as expressed in the Prologus to the fifth book of his *Chronicon*, is, it seems to me, also influenced by the simile of the Chancellor of Chartres, with whose views he must have been acquainted through GILBERT DE LA PORRÉE. The idea of progress enters, in a different context, also into the speculations of the Prologus to the third book of the *Chronicon*.

I am endeavouring to prove in my book that the influence of the Chancellors of Chartres, especially of THIERRY, can be traced in the architectural and ornamental design of the Cathedral, and that a parallelism exists between the philosophical ideas of the School and the artistic symbolism of the building. Art historians (DELAPORTE, Les vitraux de Chartres, p. 432, n. 4, Chartres 1926/27, for their part, hold the view that the representation of St. JOHN sitting on the shoulders of EZECHIEL, in one of the windows of the Cathedral, and, near by, of the other evangelists on the shoulders of the other major prophets, is connected with BERNARD OF CHARTRES' saying. But just on this point I am

(1) Lack of space prevents us from printing these testimonia none of which is anterior to JOHN OF SALISBURY. (G. S.).

very doubtful. It has to be noted that BERNARD died before the actual building of the Cathedral began, and that the windows in question belong to a relatively late stage of the construction. Moreover, BERNARD's simile contains two elements :

1) It symbolizes by the ' sitting on the shoulders ' the more advanced position of a new age in comparison to a former one;

2) It characterizes the relation of this new age to the old one as that of dwarfs to giants.

It is only the first and more general idea which is represented in the paintings of prophets and evangelists, while the really characteristic point of BERNARD's dictum is missing : The painter can hardly have intended to call St. JOHN a dwarf in comparison to EZECHIEL. Thus, if there is a relation between the literary and the pictorial expression, it is in this case a rather vague and indirect one. Besides, St. JOHN and EZECHIEL are connected even by the earliest Christian exegets both of EZECHIEL's vision of the four animals, and of the beginning of the Gospel of St. JOHN; while the connection of the Evangelists with the four major prophets is a not uncommon theme of Carolingian art.

Thus we should hesitate to admit the connection between the saying and the picture, the more so as the motive of " sitting on shoulders " or " standing on shoulders " is not expressed for the first time in the Chartres windows, but appears before as a symbol of the relation between apostles and prophets in a niche of the Merseburg font (ca. 1175; reproduced by S. H. STEINBERG & C. STEINBERG, Die Bildnisse geistlicher und weltlicher Fürsten und Herren, Leipzig-Berlin 1931, plate 145a; and G. PUDELKO, Romanische Taufsteine, Berlin 1932, plate 16) and, perhaps, on a capital at Payerne (rep. by WEESE, Die Bamberger Domskulptur, plate 28). It is evident that neither the Saxon nor the Burgundian representation is dependent on the saying of the Chancellor of Chartres. It is rather to be understood from the doctrine of the Fathers, who intend, in showing the " Concordia Veteris et Novi Testamenti," to prove both the continuity between the Old and the New Covenants and the superiority of the latter.

As to your question about the history of *the conception of progress before Bernard of Chartres*, I believe that the simile of the dwarfs is an original one and was invented by BERNARD himself. As the most important starting point, however, for him as well as for other authors, who wanted to express their theories of progress, I consider the passage from the preface to the Institutiones Grammaticae of PRISCIAN, where he says in the dedication of his work to JULIAN (ed. HERTZIUS, vol. I [=Grammatici Latini, rec. KELLIUS, vol. II] p. 1) :

" grammatica ars, ... cuius auctores, *quanto sunt iuniores, tanto perspicaciores*, et ingeniis floruisse et diligentia valuisse omnium iudicio confirmatur eruditissimorum."

That this sentence became a kind of catchword appears e.g. from OTTO OF FREISING, who quotes it in the beginning of the Prologus of the fifth book of his *Chronicon* (Mon. Germ. Hist. XX 213), where he gives an exposition of his ideas about progress, and once more in a similar context, book II, 8.

Later on, in the thirteenth century, we find PRISCIAN's words used together with BERNARD's simile in a passage from the hitherto unknown Philosophia of HENRICUS BRITO, an author who owes much to the School of Chartres. He says (Cod. Corpus Christi Oxon. 283, fol. 147ra) :

"...huic etiam consonat verbum PRISCIANI in principio Maioris, ubi dicit quod quanto moderniores tanto perspicaciores et ingenio magis floruisse videntur. Supra quod dicit PETRUS HELIAE, quod nos sumus sicut nanus positus super humeros gigantis, quia sicut potest videre quicquid gigas et adhuc plus, sic moderni possunt videre quicquid inventum est ab antiquis et si quid novi poterunt addere. Huic etiam consonat ALANUS, cum dicit : " Pygmea humilitas excessu supposita giganteo ipsius altitudinem superat."

The connection of these quotations (the author ascribes BERNARD's simile to PETRUS HELIAE) shows that they were understood as expressing the same idea. Needless to say that in the original context of PRISCIAN the sentence has not the significance 12th Century authors attributed to it. It merely serves to justify the eclectical method of the author who reproaches his Roman predecessors for having neglected the comparatively younger Greek grammarians HERODIAN and APOLLODOR. Although PRISCIAN remarks in a schoolmasterly way that by correcting and adding to the works of his predecessors an author may bring his art nearer to perfection, there is no question of a general idea of progress.

There is no doubt that BERNARD knew PRISCIAN's work. It is safe to conclude from the order of studies at Chartres that, before his Chancellorship, while " Magister Scholae Carnotensis " (1114-21), he expounded the Institutiones Grammaticae (2). It seems likely that it was BERNARD who gave to PRISCIAN's words that particular meaning.

(Oriel College, Oxford.) RAYMOND KLIBANSKY.

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(2) It may be noted that THIERRY, BERNARD's brother, included this work in his Heptateuchon, cod. carnot. 497 fol. 11 r.-157 v. Glosses on the " Priscianus maior " from the 12th Century are contained in another Chartres MS., cod. carnot. 209.

Answer to Query nº 56.—Kircher, not Nardi (*Isis* 24, 430-1).

I am indebted to Msgr. GIOVANNI MERCATI, Prefect of the Vatican Library, for the following information contained in his letter of April 25, 1936 :

Il KIRCHER nel passo da Lei citato in *Isis* XXIV (1936) p. 430 sg. rimanda a " TITI LVCRETII CARI | DE RERVM NATVRA | LIBRI SEX. | *Vnà cum Paraphrastica Explanatione,* | *& Animaduersionibus,* | D. IOANNIS NARDII | Florentini. | FLORENTIAE, | *Typis Amatoris Massae Foroliuien. M.DC.XLVII.* | SVPERIORVM PERMISSV." Tab. VIII, dopo la pag. 656. La Vaticana ne possiede un esemplare colla segnatura : " Stamp. Barb. K. VII. 40."

Quel NARDI è l'autore dell' opusculo *De igne subterraneo* (Florentiae 1641), di cui si parla in alcuni luoghi della corrispondenza di GALILEO, vol. XVIII, e dell' altra opera *De rore disquisitio physica* (Florentiae 1642).

I wish to express my thanks to R. E. OCKENDEN, of London, for his letter of April 30, which called my attention to NARDI's edition of LUCRETIUS, and which reached me in the midst of my investigations of Nardiana. A note on NARDI's life and writings will be found elsewhere (*Isis*, 26, 1937); the following remarks concern Query No. 56 only.

KIRCHER, not NARDI, deserves full credit for recognizing fragments of clepsydrae in the items represented in Figs. I and II of NARDI's Tab. VIII (see facsimile in *Isis*, 24, 431, 1936). NARDI's caption, printed on p. 656, opposite Tab. VIII, reads as follows : " Fig. I. & II. Fragmenta emulantur Silicea singulatim litantium Isidi, atque Osiridi. Apud DD. GADDIOS."

NARDI is entitled to a place in the history of Egyptology; this claim rests on the following sections of his edition of LUCRETIUS.

Pp. 495-499. Animadversio XXX. De Nili Incremento.

Pp. 499-501. Animadversio XXXI. Soluuntur Problemata duo à Prospero Alpino (1) proposita, nec enodata. The two problems are : Cur ille (Nilus) constantissimè quotannis augeatur die 17 mensis Iunij Oriente Sole; Cur ex librata fluminis terra, augmenti modum praedicant incolae. NARDI fails to mention the heliacal rising of Sirius, the Egyptian calendar, or Nilometers.

Pp. 627-632. Animadversio L. De Funeribus Aegyptiorum. Based chiefly on quotations from the classics.

Pp. 632-641. Annotationes in praenarrata Funera Aegyptiorum. NARDI studied the embalming technique of the Egyptians on mummies in the Ergasterium of FERDINAND II of Tuscany. A description of

(1) PROSPER ALPINUS (1553-1617) spent the years 1581 to 1584 in Cairo. He discussed the inundation problems in Lib. I, Cap. VIII of his *De Medicina Aegyptiorum*, Venice, 1591.

several items reproduced on the nine plates of Egyptian antiquities is woven into NARDI's Annotationes.

Pp. 642-659. Tab. I-Tab. IX, on the unnumbered rectos, with captions on the even-numbered versos facing the plates. Some of the objects were " in Ergasterio Sereniss. Magni Ducis," others, apparently, in NARDI's own collection (" Nostrum haec ornant Musaeum," " Haec apud nos," " Nostris in aedibus," etc.). Tab. I is signed, G. B[a]. Balatri (2); the remaining plates seem to be the work of the same youthful artist. These nine copper engravings are not works of art, but they are valuable as records of XVIIth-century Egyptology. The illustration which appears on KIRCHER's p. 385 differs, by the additional lettering in Figs. I and II, from NARDI's Tab. VIII facing p. 656.

I express hereby my thanks to the John Crerar Library, in Chicago, for the loan of their copy of NARDI's edition of LUCRETIUS.

Library of Congress. ALEXANDER POGO.

May, 1936.

Early American mathematics. Bibliographical puzzles.—In attempting to make a list of all American publications in mathematics before 1850, a fairly large number of titles have been found of which no copy is located in any of the great collections of such works. Quite a number of these are entry titles which were located by Professor WALTER F. SHENTON among the entry titles recently deposited in the Rare Book Room of the Library of Congress. Other titles are known through publication of a key, through advertisements, and through works listed by O. A. ROORBACH, Bibliotheca Americana, Catalogue of American publications to 1848... and Supplement to 1850.

A number of works are also known in second, third, or even sixth editions and in no earlier edition.

Two authors of arithmetics are known only by surnames in a list of American arithmetics published in 1832. These names are RAND and ENTICK. In the same article there is reference to LARKIN's Elements of Geometry, which has not been located.

It is desired to locate copies of the above works and assistance is particularly requested of libraries and mathematicians, so as to make the list more complete. Not only is it desired to locate a copy, but also to have title and collation.

One arithmetic is located for Alabama (P.A.B. BARNARD, later President

(2) GIAMBATTISTA BALATRI (ca. 1627-1669), Florentine sculptor and architect. Cf. THIEME u. BECKER, *Allgem. Lexikon d. bildenden Künstler*, vol. 2, p. 385, Leipzig, 1908.

of Columbia University), one arithmetic in French in Louisiana, one in Spanish in New Mexico, three tables in Spanish in California, but practically no other works in the southwest of the United States, in the western states, or below Virginia, are known before 1850. Information concerning any such publications is desired.

Anon., Concise arithmetician of 1829, New York State Library, old catalogue. No copy is located.

Anon., Tables with easy examples under the principal rules of arithmetic for schools. Ninth edition, improved. 1833, Philadelphia, HOGAN and THOMPSON.

Anon., Book of knowledge. 1844, Philadelphia.

Anon., Primary arithmetic for young learners, (by a principal of public schools in Philadelphia). 1844, Philadelphia, GRIFFITH and SIMON. No copy is located; this is probably J. RHOADS' work.

Anon., Deutsches Buchstabir- und Lesebuch. Germantown, BILLMEYER, 1820. No copy is located.

DANIEL ADAMS, Mensuration, Mechanical Powers, and Machinery. 1848, Keene, J. H. SPALTER & Co., Boston, PHILLIPS, SAMPSON & Co., and New York, COLLINS and Brother. No copy is located.

P. G. ANGELL, A new ratio system of arithmetic. 1849. No copy is located.

H. L. BARNUM, The natural instructor... arithmetic. 1832. No copy is located.

C. W. BAZELEY, Arithmetical rules and tables. Fourth edition, Philadelphia, DESILVER, 1820, 48 pages. This is the only edition located.

C. W. BAZELEY, The juvenile scholar's arithmetical assistant. 1826, second edition. First edition not located.

C. BECKER, Teachers magazine of arithmetic..., Easton, 1819.

JOHN H. BELCHER, Arithmetical rules and tables, as used in the public schools of the city of Boston. Third edition, Boston, 1823, 24 pages. Only edition located.

T. BURDICK, New and useful guide for the farmer,... 1. penmanship, 2. decimal arithmetick. 1831, Fredonia. New York State Library, old catalogue. No copy is located.

M. M. CARLL, Arithmetic. Philadelphia, AUNER. No copy is located.

Dr. E. T. CHANEY, The practical man's assistant... tables. 1846, Syracuse.

J. A. CLARK, Philosophic manual of business arithmetic. 1848. No copy is located of the first edition of CLARK's Intellectual arithmetic and algebra, Part I.

FREDERICK EMERSON, Primary lessons in arithmetic. Third edition,

Boston, LINCOLN and EDMANDS, 34, (2) pages, 1829. This is the earliest edition located.

FREDERICK EMERSON, The teaching of arithmetic. Boston, 1829. No copy is located.

ENTICK, An arithmetic before 1832. Full name of author has not been found nor has a copy been located; Professors A. O. NORTON and R. F. SEYBOLT suggest JOHN ENTICK, English author (reputed) of a Ready Reckoner.

THOMAS FISHER, Harmonies of mathematics. Philadelphia, C. SHERMAN, 1848. No copy is located.

JOHN GOUGH, Arithmetical rules and tables. 1812. No copy is located.

GOSS, Exercises in mental arithmetic. Cincinnati, T. ERNST. No copy is located.

M. T. C. GOULD, American repertory of arts, sciences, and useful literature. 1831, Philadelphia. No copy is located.

CHARLES W. HACKLEY, Catechism of trigonometry. 1834, New York University Press, WEST and TROW. No copy is located.

THOMAS HILL, Puzzles to teach geometry. Second edition, 1850, Boston, MUNROE and Company. No copy is located. Title is from an advertisement and copyright.

ISAAC HARRINGTON, Illustrations of arithmetic in... diagrams. 1845. No copy is located.

M. B. HOBART, HOBART's exertions (arithmetical). 1840. No copy is located.

LEWIS JOERRES, The plain calculator. 1830 or 1833 edition is not located.

JOHN KENNEDY, Theoretical and practical arithmetic. Philadelphia, CLARK, 1935. No copy is located.

JOHN KNEELY or NEELY, American arithmetic and Key. Baltimore, ARMSTRONG and BERRY. No copy of either work is located.

LARKIN, Elements of geometry. Published before 1832. No copy is located. Professor NORTON notes that the reference probably is to NATHANIEL LARKIN, Rudiments of linear, plane and solid goemetry, (London, 1820).

B. A. LUDLOW, Solution of the square of the circle. 1846. No copy is located.

H. P. LYON, Leonian interest table. 1843. No copy is located.

WILLIAM MOULTON, Treatise on GUNTER's slide rule. 1843, Boston, MUSSEY. No copy is located.

SAMUEL PARK, Arithmetic. Hartford, E. HUNT. No copy is located.

RAND, An arithmetic before 1832.

JOHN J. REEKERS, Decimal tables of interest, reduced to the denary

scale of notation. 1820, Baltimore. No copy is located. 1822, stereotyped edition, Baltimore, W. WOODDY, vii, (1), 7-19 pages.

SHEPARD A. REEVE (or REEVES), A new decimal arithmetick was published by 1807. Key of 1807 published in Philadelphia by D. HEART; 1811 Key was entered for copyright. No copy of arithmetic is located.

DANIEL B. ROSS, Principles of analysis... arithmetic... 1847. No copy is located.

Rev. J. M. SCRIBNER, SCRIBNER's engineers' and mechanics' companion... mensuration. Second edition, 1845, New York. No first edition located.

JESSE STANLEY, Practical arithmetic. 1830, Philadelphia. No copy is located.

WILLIAM W. STRATTON, Multum in parvo arithmetic. 1840. No copy is located.

LEWIS C. TODD, New and complete system of arithmetic, in five sections. 1825. No copy is located.

DALE TWEED, The teacher's and pupil's assistant. 1820, Albany. No copy is located. W. A. TWEED DALE was a teacher in the Albany Lancastrian school.

DANIEL C. UNDERHILL, Tables of arithmetic made easy. First stereotype from the fifth improved edition, New York, MAHLON DAY, 1827, 24 pages. Also 1828, third stereotyped edition. Earlier editions are desired.

AARON VICKERS, Small arithmetic for beginners, 1846.

WILLIAM VOGDES, U. S. Primary arithmetic. Advertised by E. C. & J. BIDDLE, Philadelphia, early in 1848, as "in the press." No copy is located.

DANIEL WILDER, Treatise upon geometry, in two volumes. 1848. No copy is located.

JOHN D. WILLIAMS, Arithmetical and algebraical amusements. 1840 or before. No copy is located.

University of Michigan. LOUIS C. KARPINSKI.

Harvard University.—Seminary on the History of Science and Learning (1935-36).—A seminary (the first of its kind in Harvard University) was conducted by Dr. GEORGE SARTON during the academic year 1935-36. The meetings took place on Friday afternoons from 3:30 to 5:30 in room C, top floor of the Widener Library. The average attendance was ten persons, including professors, doctors, doctorandi and students. This is a very modest beginning but it is encouraging. A list of the subjects dealt with follows. It is noteworthy that five

of the meetings were conducted by members of Massachusetts Institute of Technology (Professors T. L. DAVIS, STRUIK and WOODBURY) whose coöperation was especially welcome. The substance of two of Dr. SARTON's lectures (nos. 1, 3) is being printed by the Harvard University Press: *The study of the history of science, The study of the history of mathematics*, each volume containing an introductory bibliography (2 vols., Cambridge, Mass., 1936).

1.	October	4	Dr. SARTON: General introduction.
2.	"	18	" " : Explanation of his own work.
3.	"	25	" " : Study of the history of mathematics.
4.	Nov.	1	" " : Study of Arabic science.
5.	"	8	Prof. W. HARTNER: Determination of Chinese eclipses.
6.	"	15	Dr. R. K. MERTON: Social and cultural factors in the history of science in England in the seventeenth century.
7.	"	29	Prof. A. P. USHER: Historical process.
8.	Dec.	6	Dr. SARTON: The idea of progress. Scientific vs. cultural progress.
9.	Jan.	10	Prof. W. HARTNER: Numbers and numerals.
11.	Feb.	7	Prof. D. J. STRUIK: On the invention of the calculus.
12-14.	Feb.	14, 21, 28.	Prof. ROBERT S. WOODBURY: Egyptian engineering and architecture.
15.	March	6	Dr. D. B. DURAND: Transition from mediaeval to modern cartography.
16.	"	13	Dr. M. C. WELBORN: Study of XIIIth century MSS with special reference to „ pecia."
17.	"	20	Prof. T. L. DAVIS The origins of alchemy.
18.	"	27	JOHN N. HIGGINS: Early history of nitrogen fixation.
19.	April	10	Prof. ARTHUR D. NOCK: MOMMSEN and the study of antiquity.
20.	"	17	Prof. L. J. HENDERSON: HIPPOCRATES.
21.	"	24	Dr. SARTON: History of sexagesimal ideas.

PERSONALIA

(Members of the HSS are requested to send items for this section directly to M. L. GUINET, 11 Place général Meiser, Brussels, 3, Belgium)

Charles Atwood Kofoid.—Professor KOFOID, for many years chairman of the department of zoology at the University of California, will retire at the end of the present academic year. On his seventieth birthday, October 11, 1935, at a meeting of his colleagues and students, he was

presented with a specially dedicated volume of the University of California Publications in Zoology, of which he has long been an editor. At a special program held in his honor during the eighth annual winter meeting of the Western Society of Naturalists, six of his former students read papers. Fifty-five students have received the degree of doctor of philosophy for work under his direction. As many of these as could do so met at an informal dinner on May 2 to present him with a bound volume of manuscripts and letters of appreciation (*Science*, vol. 83, p. 460, 1936).

Max Meyerhof.—Dr. MAX MEYERHOF went to Palestine in March 1936 and delivered there a few lectures, notably before the Hebrew University on " Jewish Arabic physicians of the Middle Ages in the Near East," and another " On the transmission of Greek and Indian science to the Arabs " before the Palestine Oriental Society on March 24 in the rooms of the American School of Oriental Research in Jerusalem. After his return to Egypt he gave a lecture on April 9 before the Medical Society of Eygpt on " Mediaeval Arab science." An account of these lectures and of his visit to Palestine, together with valuable biographical and bibliographical information appeared in the journal *al-Shams* of Cairo on the 23 of April 1936 and following days. G. S.

The degree of Doctor of science (D.Sc.) has been conferred on Dr. CHARLES SINGER by the University of Oxford on July 23rd.

Mr. ROBERT S. WOODBURY (q. v., *Isis* 24, 432-33) has been appointed assistant professor of the history of science at the Massachusetts Institute of Technology, in Cambridge, Mass. Mr. WOODBURY is preparing an elaborate biography of the physicist HENRY AUGUSTUS ROWLAND (1848-1901).

Dr. GEORGE SARTON was elected on December 3, 1935 a member of the „ Samfundet för astronomisk historieforskning " (Society for the study of the history of astronomy) in Lund.

Reviews

G. L. Barber.—*The Historian* EPHORUS. xii+190 pp. Cambridge : At the University Press; New York : The Macmillan Co., 1935, $2.50.

EPHORUS has for many years past been a name to conjure with, for almost nothing is known of his life, whilst such knowledge as we possess of his works and of their influence upon his contemporaries and particularly upon the later Greek writers of history, endows him with an importance which has generally been but grudgingly allowed, but which is none the less considerable for all that.

Of EPHORUS himself we know that he came from the town of Cyme in Asia Minor, that he was a pupil of ISOCRATES, and that he had a son, DEMOPHILUS, who completed his unfinished work. When he was born or when he died is not known. What alone can be said with absolute certainty is that he lived and wrote in the fourth century; that he soon established a reputation as an historian, and that his works were valued and read until the second century of our era. In the present excellent study, which is the first to appear in the English language, Mr. BARBER makes out a good case for the beginning of EPHORUS' work as after 360 and not before 338, and for his death as at about the year 330. Thus, EPHORUS was a contemporary of XENOPHON.

The work on which EPHORUS' fame as an historian rested, his universal Histories, is at present known only from some eighty-six fragments, and from numerous passages in the writings of DIODORUS, STRABO, POLYBIUS, and PLUTARCH, to mention but a few of the writers who have expressly assigned these passages to EPHORUS, so that it has been possible to reconstruct a good deal of the form and content of the Histories. This is a task which Mr. BARBER has very efficiently carried somewhat further than his predecessors in the same field, and in so doing has given us a work which will for long remain the standard essay on EPHORUS and his works.

EPHORUS' universal Histories constituted an account of the world as a Greek of the fourth century knew it; for EPHORUS Greece was the main subject and other peoples came into his history only in so far as they were in any way connected with Greek history. His object was to create

a synthesis of world events, his intention to promote virtue and discourage vice; and in the interests of truth he commenced his Histories from the tenth century—with the Return of the Heracleidae, recording, in spite of his disclaimer of mythology, the usual legends of Heracles, the founder of the race.

The fact that EPHORUS drew upon HERODOTUS, and the Hellenica Oxyrhynchia, and possibly THUCYDIDES, for much of his information enables us to judge of his accuracy and his competence to distinguish between what was reliable and what was not, and here his abilities are shown to be of an high order, for it is evident that he attempted to verify his sources, even though he was not impartial to contemporary anecdotes.

Mr. BARBER, who was awarded The Prince Consort Prize for 1934 for this study, is to be congratulated upon an excellent piece of work.

New York University. M. F. ASHLEY-MONTAGU.

Leon Battista Alberti (1404-1472).—*De re aedificatoria libri decem.* Translated by V. P. ZOUBOV. With a fragment of an anonymous biography, translated by F. A. PETROVSKI. Vol. I—Text. XXIX+ 391 p., 2 portr., facs., figs. Classics of the theory of architecture. Moscow, All-Union Academy of Architecture, 1935. (In Russian). (15 rbls.; binding, 2.50 rbls.)

The first volume, now available, consists of an unsigned editorial preface (12 p.); of a translation of a fragment of an anonymous biography (11 p.), from the Latin of BONUCCI's edition (Florence, 1843-49); of a translation of ALBERTI's *De re aedificatoria* (385 p.), with about ninety illustrations in the text; and of a table of contents (7 p.). The second volume will contain, according to the preface, the translations of several minor architectural and related works by ALBERTI; a commentary to the texts of both volumes; and a series of chapters devoted to ALBERTI's biography, to various aspects of his activities, to source materials, etc.; the illustrations will include photographs of architectural works credited to ALBERTI, portraits, drawings, and reproductions of illustrations from various editions.

The commentary will contain exegetic notes, remarks concerning the corrupt passages of the texts, and quotations from ALBERTI's sources. It is, therefore, desirable to postpone a discussion of the translation until the commentary becomes available. A few remarks of a bibliographical nature may, however, be made without waiting for the publication of the next volume. The editorial preface states that the translation was made "from the Latin original"—not from the manuscripts reposing in Italy, but from the three Latin editions (Florence,

1485, Paris, 1512, Strasbourg, 1541). The following auxiliary sources were also consulted : BONUCCI's edition (Florence, 1843-49) of an Italian version, ascribed to ALBERTI, of the first three books; two Italian translations, by LAURO (Venice, 1546) and by BARTOLI (1st ed., Florence, 1550), respectively; the French translation, by MARTIN (Paris, 1553); the English version, by LEONI (1st ed., London, 1726) of BARTOLI's translation; and the German translation, by THEUER (Vienna, 1912). The Spanish translation, by LOZANO (1st ed., Madrid, 1582) is mentioned in the preface, but not among the books consulted by the translator. The preface does not mention the source of the chapter titles and of the table of contents; both are absent in the editio princeps, the only Latin edition accessible to me; apparently, the subdivisions introduced in the XVIth-century Latin editions were followed.

The preface states that all the illustrations of the Florentine edition of 1550 are reproduced (there were no illustrations in the Latin editions and in the Venetian translation of 1546). The engraved title-page of the Florentine edition of 1550 is reproduced, but the numerous illustrations in the text are but poor imitations of those I find in the Library of Congress copy of 1550; they are very similar to but not identical with the mirror-image cuts of the Venetian edition of 1565. A. P.

Pearl Kibre.—*The Library of* PICO DELLA MIRANDOLA. xiv+330 pp. New York : Columbia University Press, 1936 ($4.00).

One of the simplest, and generally most reliable, ways of ascertaining the breadth of a man's interests and thus something of his mental furniture is to look at the backs of the books upon the shelves of his library. In this way one may learn more about a man than years of association with him or with his writings could teach one. Certainly no one will deny that a man's library serves to throw an appreciable light upon the unadvertised sources of his mental equipment, and upon his views and opinions, and until that time arrives—if it ever does—when writers will provide their readers with running side-notes indicating as far as they are able the sources of their ideas, for all ideas of whatever kind are derivative, the student of a particular thinker and his works will find in the record of the latter's library a valuable aid to the discovery of, at least, some of those sources. With a view to providing such an aid Miss KIBRE has printed an inventory and written an analysis of the works in that "Phoenix of the wits" GIOVANNI PICO DELLA MIRANDOLA's (1463-94) library. This inventory is based upon two sources, the first an inventory published by CALORI CESIS (GIOVANNI PICO DELLA MIRANDOLA, 1897, p. 76) which contained the list of books made in 1498, four years after PICO's death, at the time of the sale of

the library to Cardinal DOMENICO GRIMANI, the second an inventory, hitherto unpublished, contained in a sixteenth century manuscript from the ORSINI collection now in the Vatican library. This second inventory, which consists of a running list of 1132 items and contains some fifty-eight items less than are to be found in the list of 1498, records a number of works which probably represent later additions made by the sixteenth century copyist: these have been disregarded by Miss KIBRE in her survey of PICO's collection; the whole inventory is, however, printed in an appendix. The date at which this latter inventory was drawn up is not known, nor is much known of its provenance beyond the fact that the volume of which it forms a part originally belonged to ANGELO COLLUCI, Bishop of Nocera (d. 1549), whose library was pillaged in 1527 during the sack of Rome. The volume later found a place in the library of Cardinal ORSINI, a former pupil and friend of COLLUCI.

The 1,190 volumes of PICO's library inventoried in 1498 must rank as one of the largest of the private libraries of the period, and judging from its titles, as amongst the most eclectic. There were some 900 works in Latin, 157 in Greek, and 124 works, all but seventeen of which divided between Aramaic and Arabic texts, were in Hebrew, the latter being in itself one of the largest collections of works in Hebrew of the period. Whilst a large number of works by the authors of classical antiquity were represented in the library the large predominance of works on theology and mediaeval scholastic philosophy attest to PICO's adherence to the main tenets of mediaeval scholasticism. Contemporary humanists were, however, extremely well represented, and belles-lettres, law, travel, occult and natural science, mathematics, astrology, the *Malleus Maleficarum*, and even the *Secrets of Women* (ascribed to ALBERTUS MAGNUS) all contributed their share to the weight of PICO's shelves. Greek medicine was represented by HIPPOCRATES and GALEN, but altogether the medical treatises of antiquity were considerably outnumbered by those of succeeding centuries. Roman medicine was represented by CELSUS, in connection with whom Miss KIBRE points out that though his work was little known during the centuries immediately preceding the invention of printing, it was not altogether unknown in the earlier Middle Ages as is attested by several extant manuscripts dating from the tenth, eleventh, and twelfth centuries, (W. S. TEUFFEL lists Mss. at Rome, Vatican 5951, 10th century; Florence, Laurent. Plutarch. 73, I, and Paris, N.B. 7028, 11th Century. Bd. II, 1910, 24).

Since PICO's career coincided in large part with the introduction of printing it is of interest to note that at least four hundred and eighty-nine of the works in his library, that is to say some forty-two per cent, were printed editions, and it is also of interest to note that none of the printed

works were duplicated in the manuscript works forming the remainder of the library; this would perhaps suggest that whenever possible PICO preferred the printed copy to the manuscript copy of a work; whatever, if any, his reasons may have been, decidedly he seems to have been partial to the printed page.

If additional evidence were needed to attest to the largeness of PICO's restless mind this record of his library would be the place in which to browse for it.

Miss KIBRE has given us an exceedingly careful and well-done piece of work which will greatly help the student to an understanding of PICO. There is an excellent index, but a portrait of PICO is lacking.

New York University. M. F. ASHLEY-MONTAGU.

Oluf Luth.—*Nogre stycker af thenn frije konst astronomia* (Cod. Holm. D 77,) med innledning utgiven av Henrik Sandblad. (Skrifter utgivna av K. Humanistiska Vetenskaps-Samfundet i Uppsala. 29:4, Uppsala, ALMQVIST & WIKSELLS Boktryckeri—A.-B. und Leipzig, OTTO HARRASSOWITZ, 1935). XXIV und 91 Seiten.

Die hier erstmalig edierte Handschrift—Cod. Holm. D 77,—deren Titel in deutscher Übersetzung lautet: " Einige Stücke aus der freien Kunst Astronomia," geht zurück auf ein verlorenes Original des im Jahre 1580 verstorbenen Uppsala-Professors OLAUS JONAE LUTH. Gemäss dem Datum des Titelblattes (1) entstand die Abschrift im Jahre 1584, vier Jahre nach dem Tode des Autors. Der Text ist im altertümlichen Schwedisch des 16. Jahrhunderts geschrieben, bietet jedoch in sprachlicher Hinsicht keine Schwierigkeiten. Die geradezu unerhört korrumpierte Form, in der uns die Abschrift erhalten ist, hat offenbar ihren Grund darin, dass der Schreiber des Lateinischen und der Astronomie völlig unkundig gewesen ist. Über die Person dieses Schreibers wissen wir nichts. Die von HARALD WIESELGREN gemachte Angabe (2), dass die Abschrift der Hand des JOHANNES BUREUS entstammt, kann wohl nicht zutreffen, da selbst der damals nur 16 Jahre alte BUREUS schwerlich sich so grobe Fehler hätte zuschulden kommen lassen. Dagegen zeigt das Exlibris des Titelblattes, dass die Schrift später im Besitze des BUREUS gewesen sein muss, ebenso wie auch zahlreiche Textverbesserungen von seiner Hand herrühren dürften.

Ausser dem Titelblatt umfasst die Handschrift 60 Quartblätter, wovon fol. 56 leer ist, sowie eine grössere Tabelle nach fol. 8 und je ein kleineres

(1) Das Titelblatt ist facsimiliert wiedergegeben in K. LUNDMARK, *Några blad ur den svenska astronomiens historia, Popul. Astr. Tidskr.*, IX, 1928, S. 144.

(2) In Reconditi Labores, Samlaren, 1888, S. 110.

Blatt nach fol. 17 und 29. Aus einer Stelle des Textes geht hervor, dass das Original ferner noch eine Sinustafel und eine Tafel der Längen eines Grades auf den Parallelkreisen, ausgedrückt in Meilen, enthalten hat.

Obgleich OLUF LUTH eine bedeutende Stellung in der älteren Geschichte der Universität Uppsala einnimmt, wissen wir nur wenig über sein Leben. Sein Geburtsjahr ist unbekannt; die Angabe, dass er in Gävle zur Schule gegangen ist, lässt sich nicht belegen, erscheint jedoch plausibel, da LUTH aus Hälsingland stammte und diese Lehranstalt in den Jahrzehnten nach der Mitte des 16. Jahrhunderts das grösste Ansehen in Schweden genoss und die Hochburg der lutherischen Orthodoxie bildete. Im Jahre 1562 wurde LUTH an der Universität Rostock immatrikuliert, 1565 in Greifswald und Ende 1570 in Wittenberg. Kurz darauf finden wir ihn als Magister in seiner Heimat, wo ihm schliesslich seine umfassenden Studien eine Professur an der Universität Uppsala einbrachten.

LUTH war in erster Linie Theolog; dies erhellt sowohl aus seinem Lebenslauf, als auch aus der von ihm verfassten Historia Liturgica, die wohl als theologische Schrift zu werten ist. Daneben verfasste er jedoch auch ausser astronomischen und dialektischen Arbeiten eine Schrift "*Dictata in librum I. Tusculanarum Quaestionum Ciceronis*," was zur Genüge beweist, dass er eine aussergewöhnlich umfassende wissenschaftliche Bildung besass; allerdings war eine solche auch vonnöten, zu einer Zeit, da der Unterricht an der Universität von nur 3 oder 4 Lehrern bestritten wurde.

Im Jahre 1576 wurde LUTH in den sogenannten liturgischen Streit verwickelt und im folgenden Jahre vom König zeitweilig seines Amtes enthoben und nach Svartsjö verbannt, um seinen Einfluss auf dem bevorstehenden Konzil auszuschalten. In den letzten Jahren dieses Jahrzehntes geriet die Unterrichtstätigkeit an der Universität mehr und mehr in Verfall, und im Jahre 1580 musste sie wegen der in Uppsala herrschenden Pest gänzlich eingestellt werden, was dem König JOHAN III die willkommene Veranlassung dazu bot, den Unterricht nach seiner jesuitischen Akademie in Stockholm zu verlegen. Der Pestepidemie des Jahres 1580 ist auch OLUF LUTH erlegen.

Die zur Diskussion stehende astronomische Arbeit entstand, wie eine Textstelle aussagt, im Jahre 1579. Die zerrütteten äusseren Umstände mögen dazu beigetragen haben, dass sie in Form und Inhalt grossenteils ein höchst unvollkommenes Gepräge zur Schau trägt. Sie bildet wahrscheinlich die Niederschrift von Vorlesungen, die LUTH an der Universität Uppsala in lateinischer Sprache gehalten hat.

Aus den Aufzeichnungen des Gotländers OLAUS JOHANNIS geht hervor,

dass schon vor 1486 in Uppsala Vorlesungen über das im späteren Mittelalter allgemein angewandte astronomische Handbuch " *Tractatus de Sphaera Mundi* " des JOHANNES DE SACROBUSTO oder SACROBOSCO (JOHN OF HOLYWOOD, gest. in der Mitte des 13. Jahrhunderts) gehalten wurden. Nach OLAUS MAGNUS (*Historia de Gentibus Septentrionalibus*, Rom, 1555, S. 52 [Lib. I, Cap. XXXII]) scheint auch zu Beginn des 16. Jahrhunderts das Interesse für astronomische Studien in Uppsala sehr rege gewesen zu sein.

Die ungeheuere Popularität der *Sphaera Mundi* des SACROBOSCO, den der schwedische Astrophysiker und astronomische Historiker K. LUNDMARK in witziger Weise als den " Sir JAMES JEANS des Hochmittelalters " bezeichnet (vgl. *Från Kaos till Kosmos*, Stockholm, 1934, S. 214), lässt sich heute nur noch schwer verstehen. Ein Hauptgrund ist wohl in der kurzen und leicht verständlichen Fassung der Schrift zu erblicken, die sich in sklavischer Abhängigkeit an die Werke des AL-BATTĀNI und AL-FARGHĀNĪ anlehnt.

Auch die Arbeit LUTHS gibt in ihren wesentlichen Zügen eine Darstellung des aristotelisch-ptolemäischen Weltbildes in der Zusammenfassung SACROBOSCOS; dies kann uns nicht befremden, wenn wir bedenken, dass die kopernikanische Theorie sich nur äusserst langsam Bahn brach und dass selbst noch im Jahre 1656 in Leiden eine Neuauflage der *Sphaera Mundi* zum Schulgebrauch hergestellt wurde. Wenn LUTH auch nicht SACROBOSCO zitiert, so zeigt die Behandlung des Stoffes, nicht zuletzt auch die Anordnung der einzelnen Probleme, dass ihm die beiden ersten Kapitel der *Sphaera Mundi* zum Vorbild gedient haben. Daneben finden sich jedoch auch Stellen, die über den Inhalt seiner Vorlage hinausgehen und von einer ansehnlichen Belesenheit des Verfassers in der astronomischen Literatur zeugen. Welche Autoren im übrigen von ihm mit verwendet wurden, lässt sich nicht ohne weiteres entscheiden, da er ausser der Bibel, sowie ARISTOTELES, ARCHIMEDES und dem Älteren PLINIUS nur den PETRUS APIANUS namentlich anführt.

Nur eine einzige der ungenannten Quellen hat sich bisher mit Sicherheit nachweisen lassen : die *Quaestiones in Libellum de Sphaera Joannis de Sacro Busto* des HARTMANN BEYER aus Frankfurt am Main (1516-1577), des Schülers MELANCHTHONS und Lehrers der Mathematik in Wittenberg. So zitiert er z.B. im zweiten " Stück " des 2. Kapitels die Längen- und Breitentafeln im *Cosmographicus Liber* des PETRUS APIANUS, aber dieses Zitat ist, wie SANDBLAD (S. XXII, Fussnote 1) zeigt, direkt von BEYER übernommen, deutet also nicht darauf hin, dass LUTH die Schrift des APIANUS selbst benutzt hat.

In seinen Beispielen geht LUTH oft eigene Wege. Mehrere biblische Beispiele hat er offenbar selbst gewählt, ebenso wie die schwedischen,

in denen Uppsala eine besondere Rolle spielt und wo ausserdem noch Danzig (" danska "), Linköping und Nyköping figurieren. Unabhängig von BEYER gibt LUTH eine Methode der Messung der Polhöhe mit Hilfe eines " Stockes " (Gnomon) und mit dem Quadranten. Nach beiden Methoden bestimmt er die Breite von Uppsala zu 60° 50'.

Die (in der Wiedergabe der Abschrift stark entstellten) Figuren gehen teilweise auf selbständige Zeichnungen LUTHS zurück.

Wenn auch die Schrift LUTHS in keiner Weise originell oder für die *allgemeine* Geschichte der Astronomie aufschlussreich ist, so hat sie doch ihre *spezielle* Bedeutung als eines der wenigen Dokumente aus der frühen Geschichte der schwedischen Wissenschaft. Sie ist das älteste uns erhaltene Lehrbuch der Astronomie in schwedischer Sprache und gewährt uns als solches interessante Einblicke in die ersten Ansätze zur Bildung einer schwedischen astronomischen und geometrischen Terminologie.

Der Herausgeber HENRIK SANDBLAD, dessen historischer Einleitung der vorstehende Bericht im wesentlichen entnommen ist, ist mit Umsicht und Sorgfalt zu Werke gegangen; die zahlreichen sinnstörenden offenkundigen Versehen des Schreibers wurden ausgemerzt und in die Fussnoten verwiesen, wodurch die Lektüre ganz bedeutend erleichtert wird; die Anmerkungen am Schlusse erhöhen den Wert der Edition. Wir sind dem Herausgeber zu Dank verpflichtet.

(Harvard University.) WILLY HARTNER.

Henry Bernard (S. J.).—MATTEO RICCI'*s scientific contribution to China.* Translated by EDWARD CHALMERS WERNER. 108 p., 6 pl. Peiping, VETCH, 1935 (U. S. $2.50).

We have already spoken at some length of Father BERNARD's very interesting study on the attitude of the Jesuit missionaries in China toward GALILEO (1935, *Isis* 25, 539). This new book of his is also a valuable contribution wherein he has been able to take full advantage of his western and Chinese learning.

Chapter 1 is particularly interesting. The author explains the debt of Chinese astronomers of the thirteenth century to Muslim science, quoting extracts from the annals of the Yüan dynasty concerning the astronomical instruments of KUO SHOU-CHING (d. 1316; *Introd.*, 2, 1022). Unfortunately under the Ming dynasty, the whole of Muslim knowledge was driven out and the earlier and inferior Chinese science reestablished. This was one of the main causes of the gradual divergence which separated the East from the West after the fourteenth century and even more so after the fifteenth. During the thirteenth and fourteenth centuries, partly because of the existence of the Muslim bridge and partly for other reasons, the world was giving a promise of growing intellectual

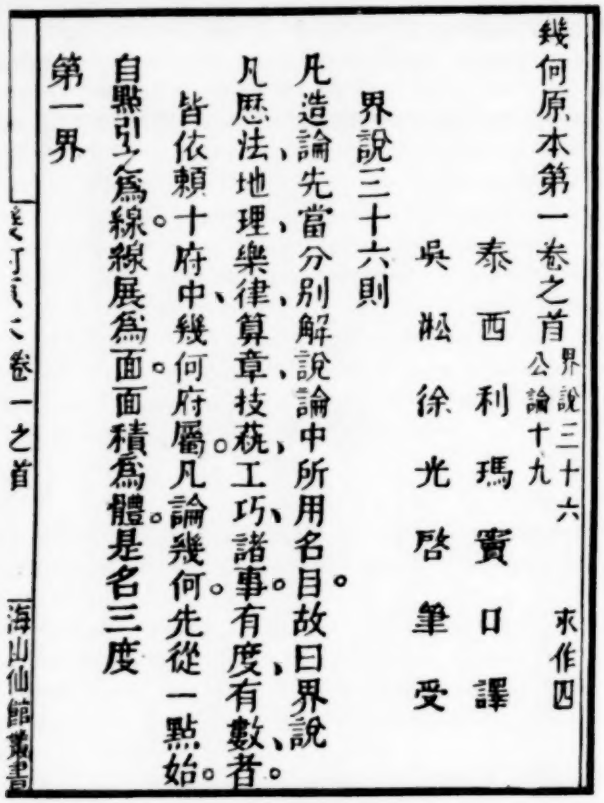
unity. This was destroyed by Chinese nationalism on the one hand, and on the other hand by Muslim obscurantism and withdrawal and soon afterward by the growth of the experimental spirit in the West, and in the West only.

MATTEO RICCI was born in 1552 and after having completed classical studies at the college of Macerata he studied law in Rome, and joined the newly founded Society of Jesus. During his six years of preparation at the Collegio Romano (1572-78) he devoted himself to the study of mathematics. Father BERNARD explains the early organization of

FIG. 1.

Portrait of MATTEO RICCI included in the Chinese biography written by his disciple GIULIO ALENI (S. J., 1582-1649) in 1636. After PIETRO TACCHI VENTURI : *Opere storiche del P.* MATTEO RICCI (vol. 2, p. 172, Macerata 1913).

mathematical studies in the school of Messina and in other Jesuit schools. RICCI was trained by CHRISTOPHORUS CLAVIUS (1537-1612), one of the two great men (PALESTRINA being the other) whose services GREGORY XIII had enlisted. CLAVIUS was a great teacher, if not a very original one, and through the offices of RICCI and other missionaries, his influence reached the eastern end of the world. Father MATTEO had to spend


幾何原本第一卷之首 界說三十六 求作四 公論十九

泰西利瑪竇口譯

吳淞徐光啓筆受

界說三十六則

凡造論先當分別解說論中所用名目。故曰界說。

凡歷法、地理、樂律、算章、技藝、工巧、諸事有度有數者。皆依賴十府中幾何府屬。凡論幾何先從一點始。自點引之爲線。線展爲面。面積爲體。是名三度。

第一界

FIG. 2.

some time in Portugal (only missionaries of the Portuguese mission were admitted to Macao) and he resided more than three years and a half in Goa and Cochin, before reaching Macao in 1582. On the faith of his record, of his masters' fame, and of his ability to predict eclipses he was greeted in China as a great mathematician and astronomer. However he knew better; he was keenly aware of his limitations—which were aggravated by the lack of books and instruments—and he made many appeals to his Superiors in Europe for better equipment and for

the assistance of a well trained astronomer (see quotations from his letters of 1605 and later on p. 56, 66, 71). He managed to train Chinese disciples who in their turn helped him to read and write Chinese : those disciples, who deserve to share his fame, were CH'Ü T'AI-SU and (PAUL) HSÜ KUANG-CH'I (1562-1633), about whom see *Isis* 24, 122-3. PAUL HSÜ helped him to prepare the Chinese translation of EUCLID which was printed in 1607; see our facsimile of the title page upon which may be read " the westerner MATTEO RICCI (three central characters of the third column from the right) orally translating, HSÜ KUANG-CH'I (three central characters on the fourth column from the right) recording with his brush." For more information on the Chinese translations of EUCLID see C. H. PEAKE, 1934 (*Isis* 22, 181, also footnote 5 on p. 175).

RICCI's training and his services to Chinese science are set forth in chapter 2 and 3; the two following chapters, which complete the book, are devoted respectively to a discussion of the " problem of Chinese astronomy," and to " the solar eclipse of Dec. 15, 1610." That eclipse which occurred a few months after Father MATTEO's death, illustrated in a scandalous manner the incompetence of the Chinese Board of Mathematics, and within the following two years another Jesuit Father, SABBATINO DE URSIS (1575-1620), (1) drew up a program of reform. " The original text is in Portuguese and only came to us in a Latin translation; since it is, it would seem, the oldest document in which Chinese astronomy is critically examined according to the data of the European science of that time, it deserves a methodical and detailed analysis." (p. 76) For that analysis we must refer our readers to Father BERNARD's book.

This little volume is rich in substance and its printing does credit to the Chinese printers. However, why did they print it on such heavy paper and thus increase artificially its bulk and cost? GEORGE SARTON.

Georg Mohr.—*Euclides danicus, Amsterdam* 1672. Med et forord af JOHANNES HJELMSLEV. Udgivet af det Kgl. Danske Videnskabernes Selskab. VIII+36 p., pls. København, ANDR. FR. HØST & Søn, 1928.

Johannes Hjelmslev.—*Beiträge zur Lebensbeschreibung von* GEORG MOHR (1640-1697). 22 p., 1 pl. (*Det Kgl. Danske Videnskabernes Selskab, Mathematisk-fysiske Meddelelser*, 11, 4). København, ANDR. FRED. HØST & Søn, 1931 (Kr. 1.20).

Until a few years ago the " geometry of the compass " (based on the

(1) See C. SOMMERVOGEL : *Bibliothèque de la Compagnie de Jésus* (vol. 8, 351-2, 1898).

proof that constructions which could be made with ruler and compass could be made with compass alone) was ascribed to the Italian (Bergamask) poet and mathematician, LORENZO MASCHERONI (1750-1800) and the relevant constructions are still called " Mascheroni constructions". (1) The first edition of MASCHERONI's *La geometria del compasso* appeared in Pavia 1797 (280 p.) with a dedication in verse " A BONAPARTE italico " expressing fullsome praise for the youthful conqueror of Italy. (2) The book was soon translated into French by ANTOINE MICHEL CARRETTE, officier du génie, *Géométrie du compas* (288 p., 14 pl., Paris an VI, 1798), and later (3) the French translation was translated into German by JOHANN PHILIPP GRÜSON and much augmented. (560 p., 19 pl., Berlin, 1825). (4) A revised and augmented edition of the French translation was published in Paris and Brussels 1828 (342 p., 14 pl.) (1).

MASCHERONI's work was thus well known in Europe, and no wonder, for one of his chief publicity agents was none other than BONAPARTE himself who appreciated mathematical praise above all other. BONAPARTE had actually studied MASCHERONI's book under the author's guidance, and when he returned to Paris he amused himself by putting forward Mascheroni problems to his colleagues of the Academy of sciences. The " geometry of the compass " is not transcendentally difficult, but like anything else it requires an initiation. BONAPARTE would ask LAPLACE for example " how to determine the center of a given circle with compass alone " and LAPLACE had to give it up. BONAPARTE would explain the matter to him and LAPLACE would finally say " General, we expected to receive anything from you except mathematical lessons." One can imagine BONAPARTE's delight, for to beat LAPLACE at his own game, was almost as gratifying to his vanity as beating the Italians (2).

All of this by way of introduction to the " Danish Euclid," GEORGE MOHR, who published as early as 1672 a book anticipating MASCHERONI and the Mascheroni constructions. That book was issued in Amsterdam in that year in two editions, Danish and Dutch. The Danish edition was reproduced in facsimile by the Danish academy in 1928 with a preface by JOH. HJELMSLEV, but as far as I am aware the Dutch edition is still practically unknown. Thanks to the courtesy of the Librarian of the University of Amsterdam, I am able to reproduce a facsimile of its title page. Please note that it includes (lower right corner) the author's signature after the mention " Printed by IACOB VAN VELSEN, for the

(1) I have examined editions (2) and (4) as well as an Italian modern edition (Palermo, 1901).

(2) MAURICE D'OCAGNE : Hommes et choses de science (3e série, Paris, 1936, 152-54). According to D'OCAGNE that particular problem was still called in a German mathematical journal of 1909 : *Die* NAPOLEONS *Aufgabe*.

EUCLIDES DANICUS,

Beſtaende in twee Deelen:

Het eerſte Deel: Handeldt van de Meetkonſtige Werckſtucken, begrepen in de ſes eerſte Boecken *Euclidis:*

Het tweede Deel: Geeft aenleyding om verſcheyde Werckſtucken te maecken, als van Snijding, Raecking, Deeling, Perſpective en Sonnewijſers:

Alleenig met een *Paſſer* te wercken (ſonder Rye ofte Liniael te gebruycken) door Snijding van Ronden.

Voorgeſtelt

Door

GEORG MOHR.

t'AMSTERDAM,

Gedruckt by *Iacob van Velſen*, voor de *Autheur*, welcke geen Exemplaren voor de zijne erkent, als die hy ſelver met zijn handt onderteeckent heeft; 1672.

Author, who will not recognize any copy as authentic, unless it bear his signature in his own hand; 1672." The Danish edition was printed by the same printer but the Danish copies were unsigned. The signature on the Dutch title page is the same as that on a letter written by MOHR to TSCHIRNHAUS (Copenhagen, Jan. 30, 1683) reproduced in HJELMSLEV paper of 1931.

That paper, the best part of which is simply reprinted from the writings of Prof. Dr. CURT REINHARDT of Freiberg in Saxony, is a collection of all that is known to-day about the Danish mathematician, GEORG MOHR—a man distinguished enough to deserve LEIBNIZ' praise. In a letter to OLDENBURG (May 12, 1676), LEIBNIZ said of him " GEORGIUS MOHR Danus, in Geometria et Analysi versatissimus."—GEORG MOHR (or MOHRENDAL) was born in Copenhagen on April 1, 1640, his father DAVID being a merchant and inspector of the hospital. He was presumably in comfortable circumstances and travelled in England, France, Holland, spending at least eleven years abroad, chiefly in Holland (3). His book, as we have seen, was printed in Amsterdam, in Danish as well as in Dutch. In Holland, he became acquainted with members of the DESCARTES and SPINOZA groups and with the German mathematician and philosopher EHRENFRIED WALTHER VON TSCHIRNHAUS (1651-1708). That was pleasant enough, but all his memories of Holland were not equally pleasant. One day he was made a prisoner and ill-treated by French troopers, and on that occasion he lost all his goods and chattels including his manuscripts. He returned to Denmark and was married in Roskilde on July 19, 1687, to ELIZABETH VON DER LINDE of Copenhagen. Later he betook himself and his family to TSCHIRNHAUS's estate in Kieslingswalde (Upper Lusatia) and he died there on Jan. 26, 1697. His widow married JOHANN FRIEDRICH SCHMIED, a chemist in TSCHIRNHAUS' service. His son PETER GEORG remained in Germany, and Germanized the original name of his family (MOHRENDAL) into MOHRENTHAL; he became a bookseller and publisher in Dresden and from 1729 on published twice a month the *Curiosa saxonica*. More details will be found in HJELMSLEV's paper, but nothing of importance.

This strange Danish figure is but a secondary personality in that seventeenth century so rich in mathematical giants, yet it deserved to arrest the attention of our readers. They should learn to say " Mohr constructions " instead of " Mascheroni constructions."

For a simple discussion of the principles of MOHR's geometry, see HJELMSLEV's article in V. MEISEN, *Prominent Danish scientists through the ages* (p. 44-47, Copenhagen, 1932; *Isis* 23, 276-78). GEORGE SARTON.

(3) OLDENBURG thought he was a " Belga," by which he meant a Netherlander (*Isis* 23, 445).

Richard Foster Jones.—*Ancients and moderns : a study of the background of the Battle of the Books.* xi+358 pp. St. Louis : Washington University Studies, New Series, Language and Literature, No. 6. ($3.00).

It may be said at the outset that Professor JONES' study admirably fulfils several useful functions for the cultural historian of science in seventeenth century England. This contribution, which follows upon the author's series of valuable articles on the relations between science and language during this same period, deals primarily with the shifts of attitude toward science from about 1590 to 1672, as reflected in the literature devoted to the place of science in the intellectual life of the day. Detailed study of writings frequently difficult of access leads to the conclusion, as one might expect, that the continued increase of interest in science, the diffusion and ever more widespread acceptance of norms of empiricism, utilitarianism and progress, and actual scientific achievements are found to develop concomitantly.

It is of particular interest that GILBERT, rather than BACON or HARVEY, exercised a predominant influence upon the minds of the intellectual élite during the first forty years of the century. It was not until the period of Puritan supremacy that BACON's precepts came to be generally considered as representative of the new spirit of experimental and observational inquiry. Inasmuch as it delineates, with systematized detail, the rich success which the Baconian propaganda ultimately achieved, Professor JONES' analysis of the rôle played by BACON in the contemporary development of science merits especial approval, for it constitutes an account of seldom equalled clarity and precision. Occasionally, however, the author seems by implication to lean toward an unduly ' heroic ' conception (for example, in his proposition that BACON's ideas " determined the scientific complexion of the century.") It is of course more warranted to maintain that BACON's resonant eloquence was utilized, not necessarily or exclusively by those whose interest in or attitude toward natural philosophy derived from this source, but by those enthusiastic protagonists of science who sought to employ every possible means for furthering their cause. The author is on more secure ground when he observes that the espousal of both the new science and Baconian conceptions was largely founded upon the identity of values involved in both.

The connection drawn between Puritanism and the newly-flourishing science provides the basis for an especially noteworthy discussion. It is concluded that " the Puritans by no means monopolized science (witness SCARBROUGH, to mention no others), but before the return of CHARLES II they were more responsible for its growth than anyone else." This fact is explained by the congruence of virtually all the social ideals and

values involved in Puritanism with the implications of the new science : materialism, utilitarianism, democracy, social-mindedness, humanitarianism and anti-authoritarianism. To be sure, the basis for Puritan utilitarianism is alluded to in a somewhat casual manner—such utilitarianism would seem to be a " psychological consequence " of the theological conceptions of predestination and *certitudo salutis* peculiar to those sects tinged with Calvinism—but this is undoubtedly due to the fact that such problems are not directly involved in the present study.

Judging from his remark that J. F. PAYNE, in his biography of SYDENHAM, " pays to the Puritans the only recognition which I have been able to discover of their espousal of the new science," Professor JONES seems to have arrived at his conclusion in complete independence from a number of similar researches now in progress or newly completed. Dean DOROTHY STIMSON has recently published a preliminay progress report with substantially identical conclusions (1); OLIVE M. GRIFFITHS has described the close relationship between Presbyterianism and scientific education in the late seventeenth century (2); and the reviewer has been led to similar conclusions by a somewhat more analytical study of the same subject (3). In addition, more or less casual observations of this connection are to be found in the works of BUCKLE, MAX WEBER, SOMBART, TROELTSCH, FRIEDELL and FĂCĂOARU, among others. This instance of independent multiple discovery, so familiar an occurrence in the history of science and of related intellectual disciplines, may perhaps be taken to afford impressive testimony of the validity of these findings. Certainly, independent identical error is highly improbable.

A brief explanation of the genesis of the title of this study may not be amiss. The title derives from the fact that the experimental methods of the new science were by implication radically opposed to dependence upon the sheer authority of classical antiquity. Hence, " in the last analysis an account of experimental science resolves itself into a history of the quarrel between the ancients and moderns."

(Harvard University.) ROBERT K. MERTON.

Johan Nordström.—GEORG STIERNHIELM, *Filosofiska Fragment med Inledning och Kommentar*. Vol. I, pp. 27 + CCCLXI; vol. 2, pp. 294. ALB. BONNIERS Boktryckeri. Stockholm, 1924.

(1) DOROTHY STIMSON, " Puritanism and the new philosophy in 17th century England," *Bulletin of the institute of the history of medicine*, III (1935), 321-334.

(2) OLIVE M. GRIFFITHS, *Religion and learning*, Cambridge, University Press, 1935.

(3) ROBERT K. MERTON, " Puritanism, Pietism and Science," *The Sociological Review*, January 1936.

GEORG STIERNHIELM was born in Dalecarlia, central Sweden, August 7, 1598. He died in Stockholm April 22, 1672. His early education in Sweden was followed by studies at Greifswald, where he enrolled in 1615, and apparently also at other continental universities. His first disputation at Greifswald, in January 1616, was " De coeli partibus astris," in which the Aristotelian teaching concerning the stars is defended. After nine years of study and travel on the continent he returned to Sweden early in 1624, but the autumn of this year found him again at Greifswald, apparently pursuing political studies. In the summer of 1625 he visited France and possibly England. In 1626 he became lecturer on ethics and politics at Västerås, Sweden. In 1630 he was appointed by GUSTAVUS ADOLPHUS to a post at Dorpat, and in 1631 was raised to the nobility.

Subsequently returning to Sweden he became known as a poet through his " Hercules," published in 1658, which remains his principal work. He is called the father of Swedish poetry. STIERNHIELM was an universal scholar, writing on mathematics, philosophy, natural history and other subjects. He became an authority on the antiquity of the north of Europe, and in 1677 was made president of the Antiquarian Institute of Sweden. He planned a great treatise on the Old Swedish and the Gothic, but this did not progress beyond a beginning. He is described as the most learned Swede of his time and the most prominent Swedish author of his century. Many of his writings have never been published. Part of this manuscript material forms the subject of NORDSTRÖM's presentation, " GEORG STIERNHIELM Filosofiska Fragment," which affords an insight into European thought of the 17th century.

In his foreword NORDSTRÖM states that the preparation of these volumes was a task which must needs be done before the numerous manuscripts of STIERNHIELM can be systematically studied and the results be made known in a series of special researches.

The present volumes include part of STIERNHIELM's philosophical writings, with an introduction by NORDSTRÖM. Volume I consists of 27 pages of Foreword and Bibliography and 361 pages of Introduction, in Swedish. Volume II consists of two philosophical papers by STIERNHIELM, in Latin, covering 202 pages, with 91 pages of Comments, in Swedish, by NORDSTRÖM. Some of STIERNHIELM's chapter headings will give, in brief, an outline of the subjects considered. Following a dedication to Queen CHRISTINA (1626-1689) and Prince KARL GUSTAF, who later became King CHARLES X (1622-1660) there is a chapter entitled *An outline of natural philosophy*, followed by chapters *On empty space*, *The problem of evil*, *Ur Monile Minervae*, *Geneologia Naturae*, and *Deus Principiorum Principium*. The second paper has chapters on *The*

Universal, On God, On the Principles of Nature, On Angels and Demons, On the World Soul, On Movement, Time and Space, On Fire and the Elements, etc., Harmony, Concerning Man, Speculations on Number, and *Varia.* The bibliography in volume I includes an imposing list of manuscripts and published references cited by NORDSTRÖM in his Introduction, and volume II is illustrated by diagrams and outlines from STIERNHIELM's manuscripts.

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O. LARSELL.

Arthur William Meyer.—*An Analysis of the De Generatione Animalium of* WILLIAM HARVEY. xx+167 pp., 11 illutsrations. Stanford University Press, Stanford University, California. 1936. $3.00.

It is at once to be appreciated that this beautifully printed little book is the result of a scholar's affection for his subject. It is amazing that it is the first detailed study of what has been called HARVEY's greatest intellectual effort. Indeed Professor MEYER's delightful foreword expresses his own astonishment at the shameful neglect of the *De Generatione* by the hundreds of Harveian Orators at London and Edinburgh. More than passing reference to the *De Generatione* has been accorded only by such recent scholars as Sir D'ARCY POWER (*William Harvey*, London, 1897), T. BILIKIEWICZ (*Die Embryologie im Zeitalter des Barock*, Leipzig, 1932), and JOSEPH NEEDHAM (*Chemical Embryology*, Cambridge, 1931).

The *De Generatione* appeared in four Latin editions in 1651, all of which were used by Professor MEYER for his analysis. He also employed the 1653 English translation, and acknowledges his indebtedness to the "dull excellence" of ROBERT WILLIS' 1847 English translation. Professor MEYER suggests that a new English translation, properly annotated by a competent embryologist, would be welcome. He acknowledges that he has a new and complete English translation. His present *Analysis*, and his well known original contributions and historical studies in embryology are ample evidence of his competency. How about it, Professor MEYER? We will welcome your translation and commentary.

In an introductory chapter, Professor MEYER suggests that HARVEY's purpose in writing the *De Generatione* was to record his many observations on the obscure problem of generation. This HARVEY inherited from his great teacher in Padua, FABRICIUS. In the 6th exercise of the *De Generatione*, HARVEY specifically states that he assisted FABRICIUS with experiments on the fertility of chicken eggs. Thus his study of generation

began in his student days between 1598 and 1602, to culminate in publication half a century later. Professor MEYER shows the anticipations of the work on generation which appeared in the *De Motu Cordis* (1628). Emphasis is also placed on the similarities in style and method in both of HARVEY's treatises, and the great dependence in both on ARISTOTLE.

After an unessential but interesting chapter on the temper of HARVEY's time, Professor MEYER discusses HARVEY's predecessors and contemporaries in embryology. He correctly concludes that HARVEY was little influenced by his contemporaries excepting FABRICIUS. There follows a description of the nature of HARVEY's treatise and of his philosophical preconceptions. In discussing HARVEY's attitude on the question of spontaneous generation, Professor MEYER agrees with HUXLEY (*Nature*, 2:400, 1870) FARRE (*Brit. Med. J.*, 2:1, 1872), and BROOKS (*Bull. Johns Hopkins Hosp.*, 8:167, 1897) that HARVEY admitted it out of courtesy to ARISTOTLE. The difficulties of obtaining any clear idea of the process of fertilization without accurate observational data is well discussed by Professor MEYER. In this connection he skillfully corrects the error into which so many excellent historians have fallen of attributing the phrase *ex ovo omnia* to HARVEY. This dictum appears on the frontispiece of the 1651 editions of the *De Generatione*, but the origins of these illustrations are unknown. HARVEY gave to Exercise 62 the heading *Ovum esse primordium commune, omnibus animalibus*, but nowhere in the text expressed the idea more succinctly. Professor MEYER doubts that the notion exerted any significant influence on his successors, or indeed that HARVEY's work stimulated any outstanding contributor to embryology. After a discussion of HARVEY's description of the generation of the chick, and of the development of mammals, Professor MEYER closes his survey with a consideration of opinions of HARVEY effort. Professor MEYER carefully reviews the difficulties of following mammalian development in the deer, which unfortunately was the chief source of HARVEY's information.

Professor MEYER limits his discussion and his copious quotations to the embryological aspects of HARVEY's book. There is a great opportunity for some one to review the work from the standpoint of the sexual habits of animals, comparative psychology, and practical obstetrics. HARVEY was a careful observer, an accurate recorder, and a shrewd commentator. That not all of his ideas on these matters were recorded in the *De Generatione* is shown by the reference in the 6th Exercise to his (lost) treatise on the *Loves, Lusts and Sexual Acts of Animals* (what a modern title !).

Professor MEYER's *Analysis* has a good bibliography and is well indexed.

It should now be supplemented by the new English translation which is available and which Professor MEYER could so ably annotate.

(*University of California Medical School*). CHAUNCEY D. LEAKE.

Isaac Newton.—*Naturvetenskapens matematiska principer*, Svensk översättning av C. V. L. CHARLIER. Lund, C. W. K. GLEERUPS Förlag, Part I (XXX and 291 p.), 1927; Part II (XII and 194 p.), 1931; Part III (VII and 158 p.), 1931.

This work is a splendid Swedish version of ISAAC NEWTON's *Principia* carried out by the late C. V. L. CHARLIER, the famous Swedish astronomer and Emeritus Professor Astronomiae of the University of Lund. The translation was published, mainly at the expenses of the Swedish Government, in the years 1927-31, during the last period of CHARLIER's life.

Regarding the high standard of CHARLIER's scientific work in general, it need not be emphasized that this translation of " the most ingenious work ever written " (as he used to call it) is also excellently done and shows the translator's wide interest and profound historical knowledge.

The first part of the translation dealing with sections I-XIV is based on the first edition of 1687. Essential variants of the editions of 1713 and 1726 are given in brackets or—in a few cases—in special footnotes. In the second and third parts, the translator follows the second edition of 1713, where the author has eliminated a number of errors which were contained in the original edition. The first part is enriched by an historical introduction and interesting photographs of a number of historical places. On the last 30 pages, the translator gives furthermore exceedingly valuable analytical notes to NEWTON's difficult pure geometrical reasoning. Unfortunately, a long sickness in consequence of a stroke of apoplexy in July, 1932, prevented CHARLIER from editing his annotations to the second and third parts. Four beautifully reproduced portraits of the Author are given as frontispieces to the three volumes. An extensive alphabetical register to the whole edition concludes part III.

It may not be without interest for the readers of *Isis* to quote some of the most remarkable dates from CHARLIER's Obituary published by Professor KNUT LUNDMARK in *Monthly Notices of the Royal Astronomical Society*, Vol. 95, No. 4 (February, 1935) pp. 339-342.

CARL VILHELM LUDVIG CHARLIER was born on April 1, 1862, in Östersund, the capital of the province of Jämtland in Northern Sweden. After having passed through the high school in his home town he matriculated at Upsala in September 1881. On March 9, 1887, he made his public defense *pro gradu* of his thesis " Untersuchung über

die allgemeinen Jupiter-Störungen des Planeten Thetis." Owing to the quality of this work he was immediately appointed Lecturer at the University of Upsala. In 1897 he was promoted by the government to be Professor at the University of Lund and Director of the Observatory there. In 1927 he retired on pension as Professor Emeritus. Having enjoyed unusually good health throughout his life he suffered a stroke of apoplexy in July 1932 and, having lain paralyzed and almost senseless for more than two years, he died at Lund on November 5, 1934.

CHARLIER was, among others, awarded the Memorial Medal of the Royal Physiographic Society at Lund in 1924, the Watson Medal of the National Academy of Sciences at Washington, D.C., 1924, and the Bruce Medal of the Astronomical Society of the Pacific, 1933. He was a member of the three Academies of Sweden : the Royal Academy of Sciences and the Royal Academies of Upsala, and Lund. He was also a member of the National Academies of Austria, Denmark and Norway, and was elected an Associate of the R. A. S. in 1908.

The published papers and books by CHARLIER exceed 150 in number. They concern not only various problems of the different branches of astronomy, but also the solutions of numerous important questions of mathematical statistics. As a theoretical statistician he rendered many excellent services to his country and university. Although not officially appointed Professor of Statistics, he in effect performed that office. In 1926 through his efforts a chair in statistics and mathematical statistics was set up at Lund University. It is characteristic of the wide range of his interests that the last period of his life was devoted to historical studies.

I find it worth mentioning that the present Professor Astronomiae of the University of Lund carries on the tradition founded by his predecessor : KNUT LUNDMARK, one of the most outstanding students of modern astrophysics, has shown a keen and steadily increasing interest in problems concerning the history of astronomy and natural science in general, and he has proved his thorough and extensive knowledge by a number of elaborate papers on historical questions.

(Harvard University.) WILLY HARTNER.

Johann Nordström (editor).—*Lychnos. Lärdomshistoriska Samfundets Årsbok.* (Annual of the Swedish history of science society). XV+ 543 p., figs., facs. Uppsala och Stockholm, ALMQVIST & WIKSELLS Boktryckeri, 1936.

N. V. E. Nordenmark.—ANDERS CELSIUS, professor i Uppsala, 1701-1744. 284 p., figs. (*Lychnos-Bibliotek, Studier och källskrifter*

utgivna av Lärdomshistoriska Samfundet, Studies and sources published by the Swedish history of science society, 1). Uppsala, ALMQVIST & WIKSELLS, 1936.

I had not yet spoken in *Isis* of the new Swedish Society because I was waiting for its first publication to give me a very welcome opportunity of doing so. The first two volumes—respectively, the first of the *Lychnos Årsbok* and the first of the *Lychnos Bibliotek*—are splendid. To begin with they are a joy to the eye, for they are printed in the best Swedish taste,—then their varied contents will give considerable pleasure to every historian of science.

The Swedish History of Science Society *(Lärdomshistoriska Samfundet)* was founded on the 12th of May 1934 at Uppsala. The number of its members is now about 2,270. The President of the Society is Professor N. VON HOFSTEN (cf. *Isis* 24, 361-6; 25, 80-94), the Pro-Rector of Uppsala University; its Secretary and also Editor of its publications is Professor JOHAN NORDSTRÖM, Uppsala; Treasurer is the Librarian HARALD J. HEYMAN, Uppsala.

The *Årsbok* will be duly analyzed in our forty-eighth Critical Bibliography, and the subsequent volumes will be dealt with in the same manner, as they appear. Thus *Isis* will include a critical table of contents of all these volumes, even as it includes similar analyses of all serials concerning our studies. It is thus unnecessary to give here and now the contents of this first volume. It will suffice to indicate them in a general way.

There are twenty-one papers, most of them in Swedish. Each Swedish paper is followed by a summary in English, French, or German. In addition there are more than 150 book reviews (p. 343-464) by a large staff of scholars, an analysis of many periodicals, a chronicle of the Society's activities since its foundation, various letters and notes from abroad, and a list of members. Good and abundant fare indeed! My warmest congratulations to the editor. For more details see the 48th Critical Bibliography of *Isis*, and following.

The first volume of the *Lychnos* library is devoted to ANDERS CELSIUS—whose name, but little more, is known all over the world. He was born in Uppsala, in 1701, being the third and last descendant of a dynasty of Swedish astronomers. His father, his two grandfathers and his great grandfather CELSIUS were all astronomers! He travelled in Europe to complete his scientific studies, and while in Nuremberg (1733) published his first important memoir, *CCCXVI observationes de lumine boreali... partim a se partim a aliis in Suecia habitas*. His main purpose was to increase the number of observations of *aurora borealis* in other localities in order to make a deeper study possible. Then he worked for some

time with EUSTACHIO MANFREDI in Bologna, and was welcomed in Rome (1734) by pope CLEMENT XII who gave him experimental facilities at Monte Cavallo. CELSIUS continued in Rome the photometric studies (sun and moon), which he had begun in Bologna. Whence to Paris where he witnessed the discussions concerning the shape of the earth between the Newtonians headed by MAUPERTUIS and the Cassinians. In order to settle the matter it was decided by the Academy of sciences to send surveyors to Peru and to Lapland; the comparison of their measurements of a degree under different latitudes would determine whether the polar diameter was shorter than the equatorial one or not.

The Lappish expedition included MAUPERTUIS, CLAIRAUT, CAMUS, LE MONNIER, CELSIUS, and others. They left in April 1736. This expedition was the great event of CELSIUS' life; it involved many difficulties and hardships (not the least of which was the fight against mosquitoes) and serious dangers. The author gives us a very full and well documented account of this. The final result was a little too good : the spheroid was proved to be flattened far more than the Newtonian calculation anticipated ! This was due to four causes of error working unfortunately in the same direction (1). After the return of the explorers to Paris in August 1737, the disputes with the Cassinian party were renewed with greater acrimony than before. MAUPERTUIS would have liked to make new measurements in the North, e.g., on the frozen surface of Lake Vättern, but CELSIUS refused his cooperation. He was probably kept back by the constitutional weakness (consumption), which caused a few years later his premature death at the age of forty-two. By the year 1740, all measurements concurred in verifying NEWTON's theories, and the CASSINIS themselves had to admit their error.

After this episode CELSIUS resumed his professorship in Uppsala, organized the establishment of an observatory (1740) and the activities of the *Societas scientiarum*. He was teaching not only astronomy, but trigonometry, gnomonics and chronology. His study of calendrical difficulties led to the adoption of the Gregorian style in 1753.

We have already discussed CELSIUS' contribution to thermometrical measurements at least twice, apropos of LINNAEUS (*Isis* 6, 421) and apropos of the author's anterior publication (1935, *Isis* 25, 220). It will suffice to recall that CELSIUS introduced in 1742 the centesimal scale *but upside down*; our scale was introduced a little later not by him but by LINNAEUS. What we call " CELSIUS " thermometer or grade, should be called " LINNAEAN," or perhaps " Swedish."

(1) However, the Lappish expedition and measurement were distinctly superior to the Peruvian ones. See I. TODHUNTER : *History of the mathematical theories of attraction and the figure of the earth* (vol. 1, 93, 1873).

ANDERS CELSIUS was not one of the very great, but he was a very distinguished man of science, and the amount and qualities of his accomplishments are truly astonishing if one remembers the brevity of his life (hardly more than twenty years of scientific work). He was one of the founders of Swedish astronomy and of Swedish science in general, and one of the first to introduce closer scientific contacts between Sweden and the rest of Europe.

The author already well known to us by his studies of 1933 and 1935 (*Isis* 22, 568; 25, 220) has done his task very well. My only regrets are that the bibliography of CELSIUS' published and unpublished writings is not more elaborate and that we are not given more information about other scientific members of the illustrious CELSIUS family. The index is excellent.

Lychnos has made a splendid beginning in two directions. *Long live learned Lychnos!* GEORGE SARTON.

Douglas McKie.—ANTOINE LAVOISIER. *The father of modern chemistry.* 303 p. Philadelphia, J. B. LIPPINCOTT Co., 1935. 2 portraits, 5 figs. in text. ($2.50).

LAVOISIER presents a difficult but important subject for the biographer. Dr. MCKIE's recent volume is based almost entirely on the original writings of LAVOISIER and PRIESTLEY, the Alembic Club Reprints, the GRIMAUX biography, and the critical writings and translations of BERTHELOT, MELDRUM, J. H. WHITE, HOLMYARD, DOBBIN, HARTOG, CAVEN, and T. S. PATTERSON. The book opens with a gracious introduction by F. G. DONNAN. The biographical details are confined almost entirely to the first and last chapters, the seven intervening chapters being devoted to a careful analysis of LAVOISIER's scientific contributions.

A list of the reports which LAVOISIER made to the Academy is an impressive reminder of his versatility, the mere enumeration of the abbreviated subjects occupying more than two pages. Among his humanitarian activities are mentioned : the improving of agriculture, the developing of industry, the lightening of the tax burden on the poor, the giving of financial aid to younger scientists and to the famished inhabitants of Blois and Romorantin, the founding near his Château de Fréchines of a free school, and the abolishing of an unjust tax against the Jews of Clermontois.

The biographical introduction is followed by a brief account of chemical thought as it lagged behind mechanics prior to the chemical revolution wrought by LAVOISIER. JOSEPH BLACK's explanation of the differences between mild and caustic alkalies is described as " the first gleam of dawn."

When LAVOISIER was beginning his scientific career, the composition of pure water was unknown. Since he wished to refer his hydrometric measurements to distilled water as a standard, he found it necessary to study the effect of repeated distillations on its density. The famous experiment in which he proved that water is not transmuted into earth and that, after distillation from metal vessels, it serves as a satisfactory reference standard for hydrometry is discussed in detail.

A quotation from his note presented to the Academy on October 20, 1772 shows how far he was at that time from the thorough understanding of combustion which he attained five years later. After describing the burning of phosphorus in air, he wrote: "The phosphorus is decomposed. The phlogiston leaves it. A very large amount of air is absorbed and combines with the white vapour." In a sealed note deposited November 1, 1772, LAVOISIER mentioned experiments by which he had discovered that sulfur and phosphorus both gain weight on combustion (even when one makes allowance for the humidity of the air) and that this gain is due to their combination with air. He did not then realize, however, that it was a particular constituent of the atmosphere which had combined with the sulfur and the phosphorus. In the light of this note, the late Professor MELDRUM believed LAVOISIER justified in claiming that he had formulated his theory of combustion as early as 1772.

The author discusses a memorandum from a notebook, plainly dated February 20, 1772, in which LAVOISIER referred to the pneumatic experiments of HALES, BLACK, MACBRIDE, PRIESTLEY, and others and mentioned "the need of repeating first, and of multiplying, the experiments in which air is absorbed, in order that, knowing the origin of this substance, I could trace what becomes of it in all the various changes..." LAVOISIER prophetically stated therein that this work was "destined to bring about a revolution in physics and chemistry," and MELDRUM observed in it "a note of exaltation, and even of inspiration." Although BERTHELOT accepted the date February 20, 1772 as correct, GRIMAUX, MELDRUM, and the author agreed that LAVOISIER must have unintentionally written 1772 instead of 1773 in this notebook, which contains other entries from February 20, 1773 to August 28, 1773.

When he published the *Opuscules Physiques et Chymiques* in January, 1774, LAVOISIER evidently believed that carbon dioxide was responsible for the increase of weight observed when metals are calcined. "Experiments, sufficiently numerous, lead me to believe," said he, "that the elastic fluid, the same whose existence I have endeavoured to prove in calcareous earth and alkalies, is capable of uniting, by precipitation, with most metallic substances; that it is, in a great measure, this principle

which forms the augmentation of weight in metallic calces (sic), which deprives them of their brilliancy, which reduces them to the form of a calx, &c." The word *calces*, which obscures the meaning, is evidently an oversight in translation. LAVOISIER used the words: " que c'est en grande partie ce principe qui forme l'augmentation de poids des précipités métalliques..." (*Œuvres* de LAVOISIER, vol. 1, p. 593).

Before the discovery of oxygen, knowledge of the true nature of combustion made slow progress, and even LAVOISIER vacillated in his views, unable to decide whether it was " fixed air," the atmosphere as a whole, the heavier part of the atmosphere, or some other " elastic fluid " contained in the atmosphere which combined with metals to form calces.

In the author's estimation, PRIESTLEY's experiments were far more systematic than most historians have realized. When he heated calcined mercury with a burning lens on August 1, 1774, he was surprised not because an " air " was liberated, but because that air allowed a candle to burn in it " with a remarkably vigorous flame." The various experiments which led PRIESTLEY to his final discovery on March 1, 1775 of the respirability of oxygen are carefully described and discussed. The author points out that PRIESTLEY had also obtained " dephlogisticated air " before November, 1771 by heating saltpeter in a gunbarrel and had watched a candle burn in it, but had not at that time recognized it as a new " air," because he believed that some particles of niter must have been present in it. The author also presents evidence to show that PRIESTLEY first isolated oxygen at Calne and first discovered its respirability at Shelburne House, London.

LAVOISIER was greatly impressed by the information PRIESTLEY gave him in October, 1774 regarding the air from calcined mercury. He repeated some of PRIESTLEY's experiments, and on April 26, 1775 read to the Academy the most famous of his memoirs: " On the Nature of the Principle that combines with the Metals in Calcination and that increases their Weight." By this time he realized that the gas which combines with the metals during calcination is not " fixed air "; that even though " fixed air " is produced when calces are reduced with charcoal, it is not justifiable to conclude that this air existed in that form in the unreduced calx. Therefore he had experimented, as PRIESTLEY had done, with the calx of mercury because it could be reduced without extraneous matter. By first reducing it with charcoal and obtaining " fixed air," he had proved it to be a true calx. After heating some of it in a retort, and collecting and studying the liberated gas, he had concluded that the principle that combines with metals and increases their weight is the purest part of the air we breathe. After repeating

a number of the experiments which PRIESTLEY had described in his *Experiments and Observations*, LAVOISIER announced on May 3, 1777 that air consists of two elastic fluids: one respirable and the other mephitic. In a memoir submitted on September 5th of that year, he advanced the view that all acids are formed by the union of non-metals with "eminently respirable air," which he now re-named oxygen (the acidifying principle, or element). In his *Traité Élémentaire de Chimie*, LAVOISIER gave a complete explanation of the new nomenclature devised by GUYTON DE MORVEAU, BERTHOLLET, FOURCROY, and himself. Since this work found ready acceptance, he was able to say in 1791: "Toute la jeunesse adopte la nouvelle théorie et j'en conclus que la révolution est faite en chimie." The events leading up to his death on the guillotine are presented briefly but effectively.

The volume is well printed and has been carefully proof-read. It contains a useful index, which does not, however, include the names of all the persons mentioned. In certain cases, at least, the Christian names ought to have been included so that the reader might know, for example, which HAÜY, which GEOFFROY, and which TENNANT are meant. The name *Thenard* is incorrectly spelled with an acute accent over the *e*. It is unfortunate that the jacket of this sound and conservative work should bear the surprising statement: "This is the first complete biography of 'the father of modern chemistry' ever written..."

Historians of chemistry will enjoy reading this valuable and modestly priced biography and will find it worthy of careful study.

(University of Kansas.) MARY ELVIRA WEEKS.

Thomas Henry Huxley (1825-95).—*Diary of the voyage of H. M. S. Rattlesnake* (1846-50). Edited from the unpublished Ms. by JULIAN HUXLEY. XVI+301 p., 13 pls., New York, DOUBLEDAY, DORAN & Company, Inc., 1936 ($3.00).

The recent publication of DARWIN's diary written during the voyage of the *Beagle* adds point and contrast to this diary of his associate in the battles for the ideas of organic evolution against supernaturalism and entrenched control in education and religion. Both voyagers profited greatly by the opportunities afforded in travel and exploration, by contacts with the varied life of sea and shore, with other floras and faunas than those of their homeland, and with primitive peoples. The opportunities differed and the selections made by each out of the rich array afforded were still more different. DARWIN's grasp seems to have been wider than HUXLEY's, possibly because of his first-hand knowledge of the results of speciation in one small field, for DARWIN was a collector while HUXLEY expresses lack of interest in the work of the mere closet naturalist.

HUXLEY had a rare opportunity to acquaint himself with the primitive mammals.and birds of Australasia but did not make the attempt to do so. He did somewhat better by the aborigines, however.

Doubtless one contributing factor in this seeming neglect lies in the fact that his shore leaves were absorbed in his courtship of Miss HEATHORN of Sydney, whom he later married. To this relation a considerable portion of the diary itself was due as it was confessedly written in part at least primarily for her perusal. A part of her diary written for him is also included in the book. The two combine to afford a pleasing picture not only of a happy relationship but of the fine traits and ideals of the great naturalist and later protagonist of the application of the idea of organic evolution to man himself.

In contrast with DARWIN's diary there is almost nothing in HUXLEY's comments on the living world which intimate that he was at that period brooding over any origin of species or man's place in nature. He, however, was very actively concerned with the structure of animals and with problems of comparative anatomy. In the crowded quarters of the Assistant Surgeon he had little room for dissection, apparently preserved no specimens, and seemingly devoted his time to careful drawings and repeated examinations with the microscope of the smaller and more transparent animals of the sea captured with a tow net at every opportunity. In this fashion he worked up his knowledge of the *Oceanic Hydrozoa*, *Sagitta*, and many other marine invertebrates. He was unable to carry out his initial plans for a study of the brains of fishes, of parasites, of the trepang, or of corals, though his opportunities for the study of the last named group were long continued during the survey of the Great Barrier Reef.

In what HUXLEY did and did not do in this memorable voyage of the *Rattlesnake* we have prophetic insight into the future zoologist, the author of comparative anatomies of the vertebrates and the invertebrates, the greatest proponent and exemplar of the laboratory method in the teaching of biology, and the originator of the study of types in the elementary introductory courses in university curricula. DARWIN was the naturalist, the collector of animals and of observations on animals under natural conditions; HUXLEY was the dissector, the anatomist, and his initiation into the morphological analysis of animal structure on the voyage of the *Rattlesnake* led to his introduction of animal morphology into educational methods in biology in the well-known HUXLEY and MARTIN's *Biology*. DARWIN capitalized his work as a naturalist in the field of biological analysis and theory, while HUXLEY established a method destined in no small degree to support DARWIN's theory of descent with modification.

The editor's introductory chapter, his account of his uncle's scientific work on the *Rattlesnake*, and the chapter entitled "HUXLEY and the Savages" interpret the details of the scientific content of the diary in the fuller light of current biological and anthropological knowledge. The book is further embellished by excellent reproductions of several of HUXLEY's notebook drawings which exhibit not only his artistic ability but also his unusual power in analysis. HUXLEY will be better known, better understood, and better appreciated in his many-sided qualities by reason of this revealing diary and its accompanying interpretation by another member of a famous family. CHARLES A. KOFOID.

C. O. Rosendahl, R. A. Gortner, and **G. O. Burr.**—J. ARTHUR HARRIS, Botanist and Biometrician. 209 p., 8 pls., 34 figs. Minneapolis, University of Minnesota Press, 1936. (Price $2.50).

This volume is a memorial to one of America's scientific leaders in the field of biometry. As an investigator, HARRIS applied the method to a wide range of subjects in many different fields and always with the aim of securing a quantitative analysis of some basic problem especially in the field of the dynamics of evolution. As a student, he came under the stimulating leadership of Professors MCCLUNG and WILLISTON at the University of Kansas, and as a young botanist under the guidance of Professor WILLIAM TRELEASE at the Missouri Botanical Gardens. Research abroad in the Galton Laboratories with Dr. KARL PEARSON, and as a member of the staff of the Station for Experimental Evolution of the Carnegie Institution of Washington at Cold Spring Harbor, New York, from 1907 to 1924, placed him in the forefront of American investigators in the field of experimental evolution. A bibliography of over three hundred titles attests his productivity and an inspection of the subjects reveals his perspective of values and the continuity of his activities. He used in a rare manner the procedure of combined field and laboratory attack upon his problems, always employing the quantitative method. From 1903 to 1909, he massed and analysed statistics of more than two and a quarter million countings and measurements on structural features of flowering plants. From 1910 to 1929, he continuously applied his methods to the study of plant saps in varied habitats in many parts of the United States. He collaborated with BENEDICT on *A Biometrical Study of Basal Metabolism in Man*, and with others on egg production. His contributions to biometric theory and computational techniques were extensive and of the highest value. They include the measurement of the correlation between a variable and the deviation of a dependent variable from its proportionate value; many simplifications in the computation of the coefficient of

correlation and its accessory statistics; the variate difference (and sum) method of calculating r; the determination of intraclass and interclass correlation coefficients; the coefficient of substratum heterogeneity; and biserial and equivalent probability correlation. HARRIS' contributions to the advancement of the frontiers of biometric methodology show the liveliest appreciation of practical needs and reflect great credit on one whose chief mathematical tool was simple algebra. His work was characterized throughout by its stimulating effects upon his colleagues and associates. Nearly one-half of his titles report cooperative research.

May 18, 1936. C. A. KOFOID.

Kenneth Jackson.—*Studies in early Celtic nature poetry.* xii+204 pp. Cambridge : At the University Press; New York : The MACMILLAN Co., 1935, $3.75.

This volume will be of interest to readers of *Isis* because of the author's suggestion that certain of the twelfth century Irish and particularly Welsh gnomic poems examined therein represent a " beginning of science, where the nature gnomes are the rudiments of physics and botany and zoology, and the human gnomes a crude psychology." (p. 136). A gnome is defined by Mr. JACKSON as " a sententious statement about universals, as well about the world of nature (' nature gnome ') as about the affairs of men (' human gnome ') " (p. 125). Since these gnomes were, it is believed, first written down long after they originally came into being, it is very probable that they are of some antiquity, hence both their importance and their interest is considerable for an understanding of the early sciential processes of thought of these peoples.

Mr. JACKSON takes exception to SIEPER's statement that Celtic poetry is " unendlich primitiv," objecting that " primitive poetry may be defined as an expression in crude verse form, without conscious literary art, of the singer's own immediate needs in an uncultured stage of society " (p. 79). The conscious literary artificiality of a great deal of Celtic poetry Mr. JACKSON considers to be a far from primitive characteristic. If Mr. JACKSON is right then there is no such thing as primitive poetry, or poetry that is primitive, for all the knowledge that we at present possess of the ' poetry ' of so-called existing primitive peoples, from the Australian to the Zuni,—and that knowledge is by no means inconsiderable,—proves very strikingly that none of these peoples use their varieties of chants and songs in any other but a highly formalized manner. This is true of the most primitive forms of which we have any knowledge, namely, the curious chants of the Bushmen of South Africa, in which a highly artificial and systematized repetitive from is obligatory. (1) What SIEPER

(1) *Cf.* ECKART VON SYDOW, *Dichtungen der Naturvölker*, Vienna, 1936.

probably meant was that the *content* of Celtic poetry was infinitely primitive. This, of course, is an overstatement, but if by primitive we are here to understand the manifestation of an early form of human thinking and reflection, then certainly the content of Celtic poetry is primitive.

Mr. JACKSON's collection of Celtic poetry together with his introductions and analyses constitutes a valuable addition to the field of Celtic studies.

New York University. M. F. ASHLEY-MONTAGU.

Ernest Wickersheimer.—*Dictionnaire biographique des médecins en France au Moyen Age.* 2 vols. VIII+461+867, leaf errata. Paris, E. DROZ, 1936. Frs. fr. 100.

" Here is brought together what I have been able to find out about the physicians, surgeons, barbers and empirics, which have been cited, some erroneously, inside of the actual frontiers of France, from the fifth century on to the end of the fifteenth." Given the high competence of the author, the long years of painstaking search among archival and literary sources, and an unparalleled familiarity with the international literature on the subject, the appearance of this work will cause immense satisfaction among the ever increasing number of the students of medieval medicine. For long years to come it will be an indispensable tool, and also correct a great number of errors which are continuously repeated from works less adequately documented. Gratefully we can but congratulate the author on this remarkable achievement. Also the publisher who has already given us numerous useful publications in this domain deserves the highest praise for producing at a very reasonable price, and in best typographical style and clearness, this book.

The names are arranged alphabetically (K is ranged among the C, Y among the I) and each notice is followed by precise bibliographical references which we are glad to see include those from LYNN THORNDIKE's complete four volumes of his monumental *History of magic and experimental science*. That the alphabetical order is determined by the given, baptismal, *nomen*, and not by the often better known family name, also that this is given in the French vernacular and not in the more familiar Latin form, is an innovation, probably not altogether welcome to some. When by this method the reader is confronted for instance by the formidable array of more than 1700 *Jean*, in about 150 cases plain *Jean* without any other name, he may well wonder if not by a distinction of *Jean* from Johann, Johannes, Ioannes, John, Jehan, Hans, Giovanni or other forms as found in the originals, or by the substitution of the family name or place name serving as such, the search might not be facilitated. I look for MONDEVILLE, nothing under M,

then I misremember that he was Jean, nothing there either, and I look both up in the supplement, in vain, hence four useless operations. But it is all my fault for had I looked in this case when I was not quite certain of the first name, in the *index onomastique* i.e. of *the* names, I would promptly have found that MONDEVILLE was Henri not Jean, and under *Henri de Mondeville* I could have read in two admirably condensed columns not only a complete biographical notice of this eminent man of the 14th century, but also a list of MSS by him not known to PAGEL, and a full bibliography. This *index* occupies the last 70 pages of the work, it is a very ingenious device which does away with overburdening the text proper with numerous cross-references. To any one following W's brief directions the innovations introduced should prove very helpful.

As regards the use of the given name for the alphabetical orientation there is no doubt that this corresponds for the majority of the cases to the practice of the times. Also am I in full accord with the use of the vernacular form, but I cannot console myself to a *Giovanni* or *Hans* becoming here *Jean* or in THORNDIKE *John*. It looks like rank provincialism this JOHN GANIVET or WILHELM SHAKESPEARE, passable in current speech, but not in lists for international use. W. has applied his scheme with remarkable consistency on a very large scale so that the question whether given names are better spelled according to the vernacular mode of their origin or otherwise can now be tested. This by itself is a great service, and I cannot resist the temptation to show by a concrete example which happens to have escaped W. how useful his entries are.

Here is a book "Guillermi Egidii de wissekere zelandini" on astrological calculations done "Ex Carpen[tras] 1494," in two incunable editions, one without typographical indications, the other printed at Cremona 1494/5, both now described in Gesamtkatalog 263-4 under *Aegidii*, Guillermus. According to the rules he ought to be in W. under "Guillaume Egidii," but he is not. So I turn to the *onomastique* and find seven *Egidii*, that is sons of Egidius (French Gilles—English Giles). After some trouble I find *Etienne* Egidii who obtained a licence in medecine at Carpentras in 1391, and searching a little more among the Guillaumes I now land on one "de Carpentras" with dates extending from 1476 to 1495, evidently the man of our book. He is a Dutchman Willem Gilliszoon of Wissekerke in Zealand, well known by Dutch biographers, a fact overlooked by W. That of course can happen to anyone and it is not for this reason that I cite the example, but to show that it is not completeness but a good and consistent method that makes the serviceableness of this book. Whether Etienne de Carpentras is truly Stephen or simply a misprint for William (Guillaume), whether he is 1391 or 1491, these are other questions, but they are properly put on the basis of W.'s clear references.

As W. anticipates in his *avant-propos*, both errors and lacunae will be found in his book. Careful checks throughout convince me that

it will need a microscope to find them. Sheer vanity makes me point out two omissions : In a book where the Englishman ROBERT GROSSETETE figures prominently, an ADELARD DE BATH cannot be left out, and that ALBERT DER GROSSE, here de Bollstaedt, became on 16 December 1931 a Saint of the Church, certainly merits mention, " ardently seeking for peace and full of hope from scientific discoveries " as pointed out by PIUS XI in his decretal letter " In thesauris sapientiae ", his example ought to appeal with peculiar force to this modern age.

W. disentangled many years ago the blunderously inflated NICOLAUS PRAEPOSITUS into three definite personalities : NICOLAUS SALERNITANUS, NICOLO FALCUCCI and NICOLE PREVOST. It was brilliant work which clarified various issues and allowed the proper appreciation of historical personages. But now under the not pretty title " PIERRE HISPANUS " he somewhat hesitatingly, still definitely, identifies whom the documents call " PETRUS HISPANUS " with Jean XXI. Here I think the Latin full name alone is permissible, till the identity with someone else can be definitely established. In this I am in accord with the British Museum Catalogue, with SARTON, and THORNDIKE who only informally speak of " PETER OF SPAIN " with one of the Popes John in brackets (in the literature we find identifications with the XXth to the XXIInd, which makes an abominable confusion). W. may be right in the identification, only he has no proof. Probably one day he stood musingly before the Pope's tomb in S. Lorenzo at Viterbo near where the learned man had been crushed in his collapsing library, perhaps he thought :

Ce n'est pas toujours la légende qui ment,
Un rêve est moins trompeur parfois qu'un document.

A. C. K.

Nakayama, Taro.—*Nihon mōjin shi,* History of the blind in Japan: 544 p. illus. Tokyo, Showa shobo, 1934. (Yen 4.50) (in Japanese).

There is no blind deity in Japanese mythology, but blindness like any other physical deformity was considered as a punishment of the gods. From very early days, however, the blind were credited with prophetic power. With the introduction of Buddhism, the idea of predestination and of any form of suffering due to previous sin, was implanted in the minds of the Japanese. Through the mercy of Buddha sight was to be restored miraculously, and in due time a few shrines especially efficacious for it were introduced. The state considered total blindness as a disability and made every effort to support such cases, but on the whole their condition was miserable.

In 754 KANSHIN, a blind Buddhist priest from China, came to Japan

and was naturalized. His religious zeal and intellect won many followers and he founded the Shodai Temple in the capital. This was a great inspiration to the blind. Also in 858 Prince HITOYASU, the fourth son of Emperor NINMEI, lost his sight at the age of twenty-eight. The prince entered the priesthood, and taught music and chants to the blind so that they could acquire a profession and support themselves. It is said that he spent his allowances from the court for the education of these unfortunate people who heretofore had to beg or accept charity from the state.

The rise of military clans in the middle ages with continuous civil war within the country brought all kinds of social evils and misery, but fortunately for the blind who were trained in music, the public craze for martial strains and the chanting of romantic tales gave them a new means of support. A long narrative romance called the *Tales of Heike* became the important repertoire of these blind musicians. Together with their musical entertainment, they often added moxa treatment, acupuncture, and massage. In spite of such accomplishments, they were not considered much above the class of beggars and outcasts.

About this time there rose in Kyushu, a group of blind priests with their own blind deity. They united in an organization, made out special prayers and scripture, and claimed to be very able in driving out evil spirits. According to the records of the 14th century, they were asked to come to Kyoto and Hiei Mountain to offer special prayers to get rid of harmful spirits.

With the advent of peace and prosperity under the Tokugawa regime in the 17th century, the blind fared much better. IYEYASU, the first Shogun, took special pains to provide law and regulation for the blind. They were allowed self-government; four official ranks were created for the professional blind such as scholars and musicians; they were exempt from all forms of taxation. This was of course prompted by the humanistic spirit of the officials, but on the other hand it helped to isolate their class still further from the others. Those who read the contemporary literature or look at the paintings of the blind, would realize that they were treated with contempt.

Mr. NAKAYAMA is a student of sociology and ethnology. Hence the present study presents many aspects of these unfortunate people which had not been noted before. Especially the latter part of the book is devoted to the lives of a few outstanding blind persons in the 18th and 19th centuries who distinguished themselves in spite of the very serious handicap.

After reading through the book one wonders if there had not been some effort made at some time to look into the cause of blindness and

try to find its cure. For judging from the various laws and ordinances, the number of afflicted increased at an astonishing rate, but nopreventive method had been thought of.

(Library of Congress.) SHIO SAKANISHI.

Sunamoto, Etsujiro.—*Zô. Elephants.* 2416 p. 431 plates and illus. With a separately bound " Résumé of the ***Elephants*** " in English. 16 p. Osaka, Sanyusha, 1931-32. (Yen 30.00) (In Japanese).

The author's father, FUKUMATSU SUNAMOTO of Osaka, is an ivory carver who interested himself in the history of elephants. The author succeeded his father not only in profession but also in interests, and at the age of ten, he surprised his father by collecting some important material on elephants. As the years went by, his zealous search was well compensated, and the present cyclopaedic work on elephants in two large volumes is the tangible result.

The work is divided into twenty-three chapters. The first nineteen deal with history, hunting and lore of elephants both from the scientific and popular sources. Such headings as " Rogue elephants," " Baby elephants," " White elephants in the East," and " Jumbo and his brilliant career," indicate the extremely uncritical and indiscriminating nature of the work. Hence translations from PLATO and HERODOTOS on elephants appear next to an account of a vaudeville show with elephants taken from a New York paper.

Chapters XX and XXI deal with ivory and ivory carving, which are the author's special field and which have not yet been dealt with by competent writers. Therefore the readers turn with much interest to this section, but they are disappointed. Mr. SUNAMOTO quotes, from Western sources, sales and prices of ivory, its chemical analysis, and various stories connected with ivory and its use. There is very little on the art of ivory carving as practised in the Orient, which was handed down from father to son. It is said that it takes several generations before this art is acquired thoroughly. For an artist must develop a sensitive touch so tha the may know the quality and possibility of a given piece of ivory before he commences to work.

Mr. SUNAMOTO's work is impressive in size, but as to its quality, one has a certain misgiving, for first the materials collected are uncritical, and secondly even though there are chapter headings, the author has no system or method in his dealing with the material thus collected. When he devotes more than sixty pages to what he calls " Humorous Hits on Elephants " and less than six pages to ***netsuke***, one of the most charming forms of ivory carving, one is slightly annoyed, but since the author states in his preface that the present work aims at no scholarship but

rather at collecting all the known material on elephants, the work fulfils its purpose. An extended bibliography and index are appended at the end of the second volume.

(Library of Congress.) SHIO SAKANISHI.

Kato, Genchi.—*Honpô iki-bokora no kenkyû : iki-bokora no shijitsu to sono shinri bunseki.* [Shinto worship of living human gods : its history and psychology] 459 p. plates and illus. Tokyo, Meiji Japan Society, 1931. (Yen 6.00.) (In Japanese).

For a long time till the present work was published by Dr. KATO, both the Japanese and Western scholars entertained the *a priori* idea that there was no Shinto shrine dedicated to an actual living human god. Because in Japan the Emperor has been called the *akitsukami* or *arahitogami*, meaning a god visible to human eyes even in his life-time, and because heroes and priests of valor and high virtues have been called gods incarnate in their life-time from time immemorial, Dr. KATO was not willing to accept this view without further research. His patient search in old records and extended tours through the country brought to light for the first time several Shinto shrines, which are historically genuine, dedicated to certain living human gods during their life-time.

First Dr. KATO gives a list of shrines dedicated to the late Emperor MEIJI (d. 1912) in his life time. As early as 1876, just ten years after his accession, a shrine was dedicated to the Emperor in Ishinomaki by a druggist KONISHI KYUBEI to commemorate the visit of His Majesty to Matsushima. In Shinano Province in 1893 another shrine was dedicared to him because the Emperor donated timber to cosntruct a provincial place of worship. All in all, Dr. KATO found six such shrines dedicated to this ruler in his life-time.

Dr. KATO classifies his findings into two main categories : those that can be dated definitely and those that cannot. There are forty names in the first class. KANSEN OKADA (1740-1816), magistrate, YOROZU MATSUOKA (1838-1891), governor, SHIGENOJO KANAI (d. 1829), inventor, and Prince MASAYOSHI MATSUKATA (1835-1924), one of the elder statemen of the Meiji period, are typical examples. It is also interesting to note that the famous Confucian philosopher, ANSAI YAMAZAKI (1617-1682), deified his own spirit while living, and Dr. KATO interprets this in EMERSON's terminology : " I the imprefect adore my own prefect."

To show that the cult still does exist, Dr. KATO mentions the case of MORITAKA HAYASHIDA (1848-) of Fukuoka Prefecture, for whom the villagers perform a religious service on November 17th every year. He has been a benefactor, counsellor, and friend to all, and his saintly life of self-denial and devotion has elevated him to the status of a living

human god. Dr. KATO goes on to say that the motive of this Shinto cult for human gods is purely ethical and never magical at all. From its lower form of nature worship, it has attained to the higher form of ethical religion.

With characteristic thoroughness, Dr. KATO bases all his statements upon facts and historical records, and his sources are clearly indicated. A chart of geographical distribution of these shrines of living human gods shows that Hiroshima, Akita, Yamanashi, and Fukui head the list, and they are comparatively backward in the degree of culture in Japan proper.

Appendices list a few articles and résumés published by Dr. KATO on this subject in English.

(Library of Congress.) SHIO SAKANISHI.

Sasagawa, Tomooki.—***Shin kyû ryôhô taisei*** (Compendium of moxa healing) (2 vol. plates and illus.) With a separately bound ***Keikyû benran*** (Handbook of moxa treatment) 57 p. Tokyo, SASAGAWA sanitarium publication office, 1935. (Yen 30).

At the close of the 19th century when German medicine was first introduced to Japan, the physicians as well as the public were so thoroughly convinced of the superiority of Western science that they abandoned their native science. In fact the Japanese of the period glorified everything Western and condemned that which was native. The author of the present treatise, a physician trained in both ancient and modern methods, lamented this sad neglect of the age-old wisdom, and began to devote his whole life to its study. At the age of seventy-two Dr. SASAGAWA was ready to present his life work to the public.

The first section of the book is devoted to a brief history of moxa and acupuncture in Japan. There is no doubt they came from China. (1) The Haung-ti's ***Ling Ch'u Ching*** and the ***Chou Li*** mention both practices. Their introduction to Japan was fairly early, and especially after 562 when the medical books together with charts and diagrams of their application were imported by the order of the Government. In the code of Taiho promulgated in 702, it states: "Female physicians should practise the art of moxa burning and acupuncture." They were ordered to train pupils.

In 982 YASUYORI TAMBA, court physician, wrote a treatise, ***I shin kô***, which deals with moxa burning. In 1081 TAMBA MASATADA, a descendant of the former, wrote another work, ***I ryaku sho***. The first treatise entirely devoted to moxa burning was written by MUNEMICHI, a courtier. About

(1) SARTON, *Introduction* (vol. 2, 78).

FIG. 1. — *Chên chiu ta ch'êng*, Cyclopedia of acupuncture and moxa. Title page of the third edition, 1680. This work, in 10 vols., was compiled from older sources by YANG CHI-CHOU, who was a court physician during the Wan-li period (1573-1619); it was published in P'ing-yang, with a preface by CHAO WÊN-PING, a provincial official of that period. The date of that edition is not known. In 1657, LI YÜEH-KUEI revised YANG's work and published it again. According to the *Ch'iu ting ssŭ k'u ch'üan shu*, this edition has the original preface by CHAO WÊN-PING. In 1680 LI prepared a new edition, revised and enlarged, and added a new preface. This is the edition of which we reproduce the title page. There are four other editions in the Library of Congress but all of these are posterior. *(Courtesy of Library of Congress and S.S.)*

this time the moxa treatment as preventive medicine became very popular, and the court records often mention it as a routine of the palace.

With the rule of the military clans, there is little mention of it. In the last days of the Ashikaga (1392-1569), however, there are frequent references. During the Êroku period (1558-1569) IKYÛ YOSHIDA went to the Ming court to study the arts of moxa and acupuncture and upon his return founded the famous Yoshida school.

FIG. 2. — Illustration taken from vol. 9, p. 48 of the *Chên chiu ta ch'êng*, showing the positions on back where moxa should be applied for ailment of internal organs. *(Courtesy of Library of Congress and S.S.)*

In the succeeding period, many famous practitioners such as DOZO MANABE and his disciples appeared. It is interesting to note the following passage in the ordinance of the Shogunate dated the second month of the year 1649 :

" Both spring and fall seasons should be started with moxa treatment, thus taking every precaution against sickness. No matter how hard you work throughout the year, once you fall ill, all your labor comes to naught and you lose your property as the result. Therefore take the treatment regularly as a preventive means. This also applies to your wife and children."

From the 7th to the 14th century, the moxa treatment was primarily for surgical purposes, but later it was also applied for internal disturbances.

After a short chapter on the various kinds and grades of moxa, Dr. SASAGAWA takes various diseases one by one prescribing specific treatment with moxa.

(*Library of Congress.*) SHIO SAKANISHI.

Ryôkichi Ôtani.—TADATAKA INÔ, *the Japanese land surveyor*. Published by the Imperial Academy of Japan. XXXV+766 p., quarto, Tokyo, 1917 (in Japanese). English abbreviated translation by KAZUE SUGIMURA. With a preface by H. NAGAOKA. V+IV+358 p., octavo, 47 ill. The Yamato Society of Japan. Tokyo, S. IWANAMI, 1932.

In his preface Professor H. NAGAOKA remarks " It is much to be regretted that in spite of the abundance of literature written in foreign languages on things Japanese, there is almost none illustrating the development of science before the opening of the country to foreign nations." I have expressed the same regret many times. With the exception of a few studies on Japanese medicine (especially since the western " discovery " of acupuncture), we have only two books worth quoting : *The History of Japanese mathematics* by DAVID EUGENE SMITH and YOSHIO MIKAMI (Chicago, 1914; *Isis* 2, 410-13), and *Scientific Japan, past and present* (Tokyo, 1926; *Isis* 10, 83-5). The publication of the present volume is thus doubly welcome. Indeed it is not simply devoted, as the title indicates, to one of the greatest and most interesting men of science of Japan, for it also includes a good summary of the remarkable and too little known growth of pre-Meiji mathematics and astronomy. It helps us to understand the development of modern Japan. That development is less miraculous than it may seem at first view; indeed the more we know of ancient Japanese science and the better do we realize that the Japanese were fully prepared for the rapid transformation which has taken place since 1868. The " miracle " which

our fathers witnessed and which we are still witnessing to-day was of the same kind as that of the transformation of the chrysalis into the imago. It is astounding enough, because of its suddenness and revolutionary nature, but it becomes less miraculous when one analyzes the long preparation which made it possible.

The author of the large Japanese memoir published in 1917, RYÔKICHI ÔTANI, professor in the Kyoto Imperial University, was induced to write it because of his discovery of a diary wherein INÔ had recorded all the details of his great undertaking, the survey of Japan, from beginning to end. Many of INÔ's instruments are still preserved by his descendants, and many of his maps are extant, or at least were extant before the earthquake of 1923.

The first chapter (of the English translation) is a brief account of the history of astronomy, mathematics and land-surveying in Japan and of the introduction of European science. The first contacts with Europeans in the sixteenth century led to violent anti-Christian and anti-foreign reactions, nevertheless there existed already " in 1659 a book entitled *Kenkon-bensetsu* (Discussions of the universe) written by GENSHÔ MUKAI and others. The original of this work was brought over by some Christians who came adrift to the shores of this country in 1643, and was first translated into Japanese in Roman script by CHÛAN SAWANO (originally, CHRISTOVÃO FERRIERA), a Portuguese who was naturalized as a Japanese. MUKAI translated this work into Japanese writing with some notes " (p. 15). In the seventeenth century a few (very few) Japanese scientists obtained some knowledge of Western science through the Chinese translations and treatises prepared by Jesuits, e.g., GIACOMO RHO, ADAM SCHALL and FERDINAND VERBIEST; later more knowledge percolated through Dutch books, for example, a Dutch translation of LALANDE's astronomy was available in Japan before the end of the eighteenth century, and finally in 1798 (1) TADAO SHIDZUKI " wrote the *Rekishô-shinsho* (A new book of astronomical phenomena) on the basis of JOHN KEILL's work, and as an appendix to his book, SHIDZUKI gave his own opinion which resembles the nebular hypothesis " (p. 17). The introduction of surveying occurred in the period 1624-1643; the first Japanese surveyer being GON-EMON HIGUCHI of Nagasaki who was trained by the Dutchman CASPER, and in his turn trained many countrymen of his. The first Japanese book on surveying was prepared in 1694, and various others appeared in the eighteenth century.

(1) SMITH and MIKAMI (1914, p. 263) give the date 1803, adding that the *Rekishô-shinsho* was never printed. JOHN KEILL (1671-1721) was professor of astronomy in Oxford.

Surveying seemed to have appealed with particular strength to the best scientific minds of those times.

In chapter 2 we are given biographies of some of the early astronomers who continued the assimilation of western astronomy, and began original investigations along western paths : GÔRYÛ ASADA (1734-99), YOSHITOKI TAKAHASHI (1764-1804) and his two sons, SHIGETOMI GORÔBEI HAZAMA

TADATAKA INO AND HIS AUTOGRAPH

(1756-1816). TADATAKA INÔ (or INÔ CHÛKEI), the account of whose life and activities fills the rest of the book, was born in 1745 and died in 1821. His adoption into a rich and distinguished family gave full scope to his genius; yet the early part of his life was sacrificed to business (brewery), and he was fifty years old when he became the pupil of TAKAHASHI, nineteen years younger than himself.

" TAKAHASHI, in teaching his pupils, made it a rule to instruct them by a gradual process—that is, each pupil had first to master, before coming to the new theories

of western countries, the *Shou-shi* Calendar designed in the Orient and then only was he allowed to advance to western astronomy expounded in the first and second volumes of the *Li-hsiang-k'ao-ch'êng* (2) and not yet modified by the theory of the elliptic orbits; and after he thus accustomed himself to astronomical computations, he was then permitted to study the new theory of the elliptic orbits in the Sequel of the *Li-hsiang-k'ao-ch'êng*. Since INÔ had mastered by his own efforts the *Shou-shi* Calendar before coming to TAKAHASHI, he evidently commenced a study of the first and second volumes of the *Li-hsiang-k'ao- ch'êng* immediately following his matriculation " (p. 69).

Though the Japanese had been much interested in surveying, no survey map had been made in Japan until about 1800 (3).

" The following reasons might be given. (1) That the so-called land-surveyors were mostly mere theorists, seldom gifted with real ability to apply their knowledge to practical affairs freely as the occasion demanded. (2) That, among ordinary land-surveyors, almost none was capable of accurately measuring astronomical longitude or latitude. (3) That the measuring instruments were so coarsely constructed that their errors were gross; especially the portable astronomical instruments were like toys and not suited for an accurate survey of an extensive area. (4) That it was impossible to make a free survey in the estates of feudal lords unless by order of the Shogun or under special circumstances " (p. 78).

INÔ's life was henceforth entirely dedicated to the survey of Japan which he accomplished with extraordinary skill and persistence. This is very well told in ÔTANI's book; INÔ's immense undertaking is fully described, then his methods and instruments are discussed, as well as his way of adjusting errors and his system of map-construction, and the accuracy of his survey and maps is carefully estimated. Two final chapters deal with the labour and cost of his surveys, and the instruments, maps, books and documents which have come down to us.

SIEBOLD obtained a copy of INÔ's map of Japan and published it in 1840. Later maps of the country were based completely or partly on INÔ's.

For the sake of comparison, I beg the reader to remember that the organizer of the U. S. Coast Survey was FERNAND RUDOLPH HASSLER

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(2) The *Li-hsiang-k'ao-ch'êng* is a collection of mathematical and astronomical treatises in 42 vols. It includes astronomical and logarithmic tables compiled by father IGNACE KOEGLER (1696-1746) and father ANDRÉ PEREIRA (10 vols. Peking, 1738). That work was the main vehicle of the new (Keplerian) astronomy in China and Japan. In his paper on the " Introduction of modern science into China " (*Isis* 22, 173-219, 1934), C. H. PEAKE remarks (footnote 3, p. 175) " The Jesuits of course adhered to the Ptolemaic system." This is not quite true as has been very well shown by father HENRI BERNARD : GALILÉE *et les Jésuites des missions d'Orient* (1935; *Isis* 25, 539).

(3) A map of Japan had been made in 1778 by GENSHU NAGAKUBO, but it was only a small one and not based on actual survey (p. 75).

(1770-1843) and that the operations were started only in 1816. In this respect Japan was apparently ahead of America. See CAJORI's biography of HASSLER (1929; *Isis* 13, 119-21) and his "Century of American geodesy" (*Isis* 14, 411-16, 7 maps, 1930).

This book has been written and printed with great care, but the absence of an index is regrettable. When books on Japanese or Chinese science are printed in the West it is generally impossible to include Chinese characters or Japanese *kana* because of the expenditure; however, a book printed in Tokyo (and very beautifully printed) has no such excuse for omitting to give the original forms of the oriental names, and such omission is truly inexcusable.

Professor ŌTANI's book is an important addition to our knowledge of Japanese culture; nevertheless Professor NAGAOKA's regret still deserves to be repeated. When shall we be given a complete history of pre-Meiji science?

GEORGE SARTON.

Ysander, Torsten.—*Studien zum B'eštschen Ḥasidismus.* XXII+448 pp. Uppsala Universitets Årssakrift 1933, Uppsala, A-B Ludequistska Bokhandeln.

Books on Ḥasidism have come to be of absorbing interest to students of mysticism and lovers of the intangible in human life in general. But, while there is an abundance of literature on the subject from Jewish sources, scant notice has been taken of it by Christian scholars, with the sole exception of PAUL LEVERTOFF, who was the first to examine its teachings and doctrines critically. The book before us is the first serious attempt by a non-Jewish scholar to evaluate critically and historically this strange and curious movement of romantic mysticism, which, born some two hundred years ago in an obscure and little known part of Europe, has quickly spread to almost every part of world-Jewry, producing men and creating a literature which have left their mark upon the present age. And Dr. YSANDER has written with a warmth, sympathy, insight, understanding and rare scholarship which will make his contribution stand beside the works of BUBER, DUBNOW and HORODETZKY.

The book opens up chapter after chapter in the life of a movement the name of which is known to only few scholars not of the Jewish fold. Dr. YSANDER not only tells the amazing story of ISRAEL BEN ELIEZER, called BA'AL ṢEM ṬOB, BEŠṬ, in abbreviation, the founder of Ḥasidism, describing the teachings, rites, customs, rituals, observances, to the very mystical songs and dances of the movement, but lets us in on the religious, social and historical causes that made this sect possible. He traces the development of the great mystic cults in Jewish life, how

they were influenced by the upheavals in the history of the Jews, the saintly leaders who had inspired the new mystic schools of thought, and the literature that has grown up as a result of these movements. The author proves that, though a child of the eighteenth century, the roots of Ḥasidism reach much further back; that there has never been a time in Jewish history, when, in spirit and essence, Ḥasidism did not exist. The mystic flight of the movement is older than ISRAEL BA'AL ṢEM TOB, older even than the Kabbalah with which it is usually associated, its origin reaching deep down into the very subsoil of Jewish history and literature. In Palestine, in Babylon, in Spain, in Germany, in Poland, in fact, wherever Jews and Judaism had found a home, vague intimations of the mystic longing for God were to be found.

Directly, however, Ḥasidism was the product of the tortured and twisted life of the Jewish people during the seventeenth century, when, between 1648 and 1658, no less than seven hundred Jewish communities, with a population of one hundred thousand Jews, had been wiped out in Poland as a result of the CHMELNITZKI rebellion. Mysticism then represented to the Jews a means of escape from the unbearable here and now into the realm of the daring, often childish, speculations of the Kabbalah, into "What is above and what is beneath, what is before and what is after." The Jew could not change the world; he could not change his environment; but he could change and modify his inner life that even the pain of living might become to him a source of spiritual exaltation. A system of storming the throne of God by means of prayer, fasting, penitentiale xercises, and other such superstitious practices, developed, which led thousands to regard life with despairing hearts and joyless eyes. The Kabbalah and the Zohar, The Book of Splendor, which preserved the rabbinical interpretation of the spiritual nature of the universe, helped the unfortunate victims of despair in their delusion. Rooted in allegorical exegesis that found an inner meaning in the very numbers, letters, words and accents of the Torah, the sufferers from persecution had been led to believe that if only they knew the divine mysteries, if only they understood the combination of the letters spelling out the name of God, this very physical world with its tormentors might be overcome.

It was in such a background that ISRAEL BA'AL ṢEM TOB was born and Ḥasidism came into being to lift the fallen spirits of the Jews of Poland to a height of pagan joy and a doctrine of a buoyant optimism. He alone practically created Ḥasidism. He had in a superlative degree the genius of stimulating noble and exultant feelings in the simple, illiterate masses, of stirring them to divine worship of a high order. He was himself poor and ignorant, preferred nature to books, but

he had the imagination of a poet, the vision of a prophet, and the soul of a saint. He loved the open spaces of the Carpathian Mountains where he was born and where he communicated with God. He was kindly, gentle, tender and sympathetic, which made people call him BA'AL ṢEM TOB, "The Man of the Good Name." He taught that life was to be enjoyed, the universe friendly and not filled with ghosts and demons; that piety was inward conviction and not outward conformity; that God was in the simple and unaffected heart of the passant and not only in the well-stored mind of the scholar, and that man may serve God by eating and drinking as well as by fasting and praying. A mystic, he prized the inner experience, and had little regard for the authority of tradition. Prayer was the inner bond between man and his Creator, but it must be devout, rapturous, spontaneous, and not dead letters of lip service. He also taught the doctrine of Humility, which made Ḥasidism one of the most democratic of Jewish religious organizations. It was, however, his emphasis upon *Simḥah*, or the joyousness of religion, that contributed to the novelty and originality of the movement Rabbi ISRAEL had created. He broke through the fences of the Kabbalah by insisting that man is not to approach his Creator in tears and weeping, but with a happy and singing heart. Gloom, he taught, was the devil's safest method of tempting man to sin. By driving out fear and gloom from the hearts of his people, he made Judaism a happy and healthy experience.

As the years passed, the sect Rabbi ISRAEL had founded gained in power and influence, at one time comprising nearly half the Jews of the world. After him came disciples of the same mind, in whose hands, however, the movement weakened because of internal wranglings over political and ecclesiastical matters, but chiefly because of the introduction of the *Zaddik*, or the Man-God, concept, which became a source of corruption and decadence in Ḥasidism. The *Zaddik* is represented as the root and soul of creation, the spiritual artery through which flows the life-force of the universe, dispensing blessings and conferring even material prosperity. It is easy to see what source of corruption such super-mundane authority as *Zaddikism* conferred could become in the hands of unprincipled demagogues.

Jewish and Christian scholars alike should be grateful for the thoroughness, depth, wide range of scholarship and intellectual ingerity with which Dr. TORSTEN YSANDER has treated the subject of Ḥasidism. He has blazed a trail, which, it is hoped, others will follow. There is much in Ḥasidism for pioneer work yet to be done, much of illuminating material and fascinating interest.

(Brooklyn, N. Y.) JACOB S. MINKIN.

Gotthelf Bergsträsser (1886-1933).—*Grundzüge des islamischen Rechts.* Bearbeitet und herausgegeben von JOSEPH SCHACHT. VIII+145 p. Berlin, DE GRUYTER, 1935.

This is volume 35 of the textbooks issued by the Berlin Seminar für orientalische Sprachen; Professor BERGSTRÄSSER at his early death in 1933 (1) left behind the Ms. of a course of lectures in Muslim law in the Seminar and Prof. SCHACHT at the suggestion of the Director of the Seminar has worked that Ms. up into this little handbook. He used also other lecture notes and papers left by Prof. BERGSTRÄSSER and the whole has been revised by Prof. SNOUCK HURGRONJE. The compilation, then, largely due to Prof. SCHACHT's labours, may, within its limitations, be regarded as trustworthy. For it has very distinct limitations and cannot be regarded as a complete handbook. General introduction on Muslim law is almost entirely lacking and there is nothing on the Muslim theory of the state on which so much of the canon law depends. There is very little on the two great principles of " agreement " and " difference " which are fundamental for the development of the new Islam. Again, this is a manual of Hanafite law only and its basis is the quite late compilation of BURHÂN AD-DÎN MUḤAMMAD BIN IBRÂHÎM AL-ḤALABÎ who died A.H. 956 = A.D. 1549. So we have here the final development of Hanafite law, a working lawyer's manual of actual law with only very occasional reference to the historical development and the differences with the other schools. The book has long been known and studied and there is a French translation by H. SAUVAIRE (Marseille, 1882); its high standing is very plain in the article on its author in BROCKELMANN's *Geschichte* (II, p. 432). The value, then, of the present little book is to give a " handy " precis of a great part of a law-book which ruled in Turkey down into the nineteenth century. There are two good indices and that of the Arabic law technicalities should be especially useful. D. B. MACDONALD.

Collected Papers of Charles Sanders Peirce (1839-1914).—Volume VI: Scientific Metaphysics. Edited by CHARLES HARTSHORNE and PAUL WEISS. Harvard University Press, Cambridge, Mass. ($ 5.00) (2).

The larger portion of the essays which compose this volume was published during PEIRCE's lifetime. Indeed, the core of this book is

(1) See obituary by MAX MEYERHOF (*Isis*, 25, 60-62).

(2) Earlier volumes were reviewed in *Isis* as follows: Vol. I in vol. 19, 217-20, by H. T. DAVIS; vol. II in vol. 19, 220-29, by W. V. QUINE; vol. III in vol. 22, 285-97, by W. V. QUINE; Vol. IV in vol. 22, 551-3, by W. V. QUINE; vol. V in vol. 23, 477-83, by C. MALIK.

the classical series of *Monist* articles which DEWEY and JAMES found so provocative. Several essays, hitherto unpublished, supply additional detail for the structure of PEIRCE's metaphysical thought, and the volume as a whole will put scholars in a fair position to judge the significance of PEIRCE's labors in cosmology.

PEIRCE's work, despite its original aspects, made little impression upon the scientific thought of his day. This will not appear altogether strange if we remember that PEIRCE embedded his novel emphases in an idealistic metaphysics which was of recognizably close kinship to the discredited *Naturphilosophie* (2). PEIRCE believed, for instance, that an idealistic foundation was essential to the theory of objective probability. Under other auspices, his suggestions might have found a more immediate hearing from scientific theorists. But, as it was, they were insulated by their repellent covering.

PEIRCE's writings are enlivened by his evident conviction that what he was saying was worth saying. The reader who is dispirited by contemporary philosophic studies will find in PEIRCE's metaphysical essays an invigorating quality. None the less, PEIRCE's work will disappoint those who have hoped to find in it an exemplary application of scientific logic to metaphysics. There were two sides to PEIRCE, one that looked forward to the reconstruction of logic and science, and the other which looked backwards to the traditional metaphysical formulations. The less progressive side tended finally to dominate his cosmological studies; as presented in this volume, they impress one as conspicuously lacking in adequate analysis. PEIRCE can be classified as a member of the movement which, at the end of the nineteenth century, undertook the extensive application of the evolutionary method. His achievement in metaphysics was not of the first order.

PEIRCE's system is a system of idealism with such additions and modifications as were necessitated by his devotion to the principles of absolute chance and continuity (tychism and synechism). That these notions are inseparable from an idealistic groundwork was to PEIRCE's mind indubitable. The principle of continuity, for instance, provides the logical basis of idealism for it implies the warning to avoid inexplicable hypotheses (p. 118), and thus gives warrant to the enthronement of the "sole self-intelligible" substance, Mind (p. 42). This looks very much like a capricious bias in favor of mind, and at any rate, we are not informed as to the meaning of "self-explicable." Indeed, if we adhere to the scientific conception that explanation is relative to the premisses of the given system, it would seem that "self-explicable" and "inexplicable"

(2) HELMHOLTZ's attitude toward the *Naturphilosophie* was typical of nineteenth-century science. Cf., *Popular Lectures on Scientific Subjects*, pp. 7-8.

are equivalent notions. We may therefore be justified in doubting the fecundity of PEIRCE's principle of synechism.

The doctrine of chance furnishes PEIRCE with a cosmological argument for the truth of idealism. " Wherever chance-spontaneity is found, there in the same proportion feeling exists. In fact, chance is but the outward aspect of that which within itself is feeling." (p. 174). Mind is not subject to law in the same rigid sense that matter is (p. 108). PEIRCE and EDDINGTON are thus close metaphysical neighbors.

The cosmologic units in PEIRCE's system are feelings, and they have a continuous extension in space and time (p. 184). In a Schellingian manner, " the feeling at any point of space appears to spread and to assimilate to its own quality, though with reduced intensity, the feelings in the closely surrounding places." Feeling thus acts directly on feeling continuous with it. In accordance with this approach, it follows that matter is a form of mind whose habits are so indurated " as to cause it to act with a peculiarly high degree of mechanical regularity, or routine " (p. 184, 138). The interactions of mind and matter are, in similar fashion, a special case of the universal law of mental association.

Conjoined again with this idealist foundation is PEIRCE's theory of the laws of nature. The laws themselves first arise as the forms which the original vague potentiality takes as it differentiates itself (p. 140). Their evolution is a corollary from the readiness of mind to take on novel habits (p. 431). No particular law of nature is absolute, for all laws are the products of an evolutionary process. A privileged position, however, is assigned to the " sole fundamental law of mind," for it is " the only tendency which can grow by its own virtue, the tendency of all things to take habits." Final causation thus has a basic status in nature. The evolution of law, moreover, proceeds in a kind of Darwinian way; chance divergences from law operate to increase the variety of the world, and are in turn checked by natural selection. PEIRCE avers that all this is a hypothesis capable of being tested by experiment (p. 85).

PEIRCE's theory of evolution is more drastic than SPENCER's inasmuch as its domain includes the laws of nature. The concept of evolution, however, does not now hold the primacy in scientific theory which it once held, and PEIRCE's version of evolutionary philosophy will probably share with SPENCER's in this general abeyance. After all, notions like " evolution " and " habit " have significance only within delimited biological and psychological contexts. Evolution, for instance, denotes the course of a history, but the details of the history are explained in terms of efficient causes; evolution is not a sufficient principle of explanation. Biological research, for example, now aims to discover the mechanisms

of evolution. The notion of an evolving law, furthermore, is devoid of meaning because it seeks to extend the application of " evolution " beyond its proper level of discourse. The generalization of an idea must conform to limits of significance. The discovery of " habits " in nature is no solution of metaphysical difficulties, for what meaning has a " habit," which unlike all other habits, is an irreducible trait?

In his younger days, PEIRCE cogently criticized the Hegelian dialectic for its transitions from something to nothing (p. 436). In his later philosophy, however, PEIRCE adapted to his uses an inverted form of the dialectic which performed the essential evolutionary transition from nothing to something. He thus asserts that we must " suppose an initial condition in which the universe was non-existent, and therefore a state of absolute nothing " (p. 147). This " nothing," nevertheless, is a " germinal nothing," " absolutely undefined and unlimited possibility " (p. 148). PEIRCE further declares that his objective logic differs from HEGEL's in so far as it allows for freedom; nothing *necessarily* results from it (p. 204). But when he goes on to say that the logic of freedom is that " it shall annul itself " (p. 149), it would seem that his position fairly coincides with HEGEL's. In this section of his cosmology, PEIRCE's disloyalty to his own pragmatist theory of meaning is most in evidence. What can it mean, for instance, to say that time arose from non-temporal being by a kind of " objective, logical sequence "? (p. 147). If the test of a notion's significance is its translatability into experiential content, it would seem that PEIRCE's lapses into non-significance are manifold.

PEIRCE's chapter on the doctrine of necessity is perhaps his most famous single paper. The arguments he advanced are now so much a part of the assumed information on the subject that some effort is required to judge it in its historic context. The variety of the universe, PEIRCE argued, is constantly increasing; uniformities are never absolutely exact. Since variety, moreover, cannot have its origin in uniformity, it follows that the doctrine of necessity is an unjustified prejudice. PEIRCE's use of the notion of " pure spontaneity " corresponds to " emergence " as used in recent speculations. The principal objection to his argument would naturally be directed against its postulate that material variety cannot be diversified without impairing the constancy of formal uniformity. An effect may, in certain senses, be more complex than its cause; determinism is not committed to a medieval maxim of equality of qualitative complexity (3).

(3) On this point, LOVEJOY's trenchant analysis deserves especial citation. Cf., ARTHUR O. LOVEJOY, The Meanings of " Emergence " and its Modes, *Proceedings of the Sixth International Congress of Philosophy*, p. 20, ff.

It is, of course, true that no set of experimental findings reaches absolute exactness. On the other hand, it would be an egregious fallacy to base a theory of indeterminism on such support. For one would then be assuming that the inexactnesses of all experimental data are themselves exact experimental confirmations of the hypothesis that nature is "inexact." But this would mean that every experiment is partially designed to determine the "exactness" or "inexactness" of nature, and this hardly seems to be the case. PEIRCE himself does not give a definition of "exactness" which would render it amenable to experimental determination. He even states at times that the minute deviations from law are too small to be observable (p. 69). And yet he also contends that if we were to trace sufficiently far back for the causes of observational errors, we would be "forced to admit that they are always due to arbitrary determinations, or chance" (p. 37). The whole question seems to have been left in his mind in a highly unclarified state.

PEIRCE was one of the founders of modern logic. He differs profoundly, however, from his successors with respect to its philosophical interpretation. PEIRCE sought to base his logic on a metaphysical ground, and at times even moved too far in the Hegelian path of identifying logical forms with natural processes. One still cavils at the assertion that the motions of the decapitated frog coincide with the syllogistic form (p. 189). There is, however, much suggestive material in PEIRCE's attempt to provide a naturalistic basis for the practice of inductive logic (p. 13), and his incidental remarks on the relation of instinctive to scientific logic (p. 381) also deserve attention. The anti-intellectualist connotations which PEIRCE seems occasionally to attach to his theory should not stand in the way of their incorporation into the philosophy of logic.

PEIRCE valued his reflections on philosophic method as the most permanent achievement of his thought (p. 413). But if his philosophy is not of the first order, it is because he never developed with fullness the consequences of the method which he advocated. His ambiguous loyalty to the pragmatist theory of meaning is particularly revealed in the unfortunate portions of this book on spiritualism, God, psychic research, and immortality. PEIRCE adheres, for instance, to a kind of agnosticism, although he grants that he cannot even conceive immortality (p. 354). He thus abandons his scientific logic for the expression of a non-significant doubt. He is again the bad pragmatist in cosmology when he expounds his description of matter as constituted by mental elements, for this "mental" matter is deprived of every trait which we denominate as mental; the reduction of matter to mind is only verbal because the conception of "mental" leads to no pragmatic consequences. We may even doubt the fruitfulness of PEIRCE's definition of mind as

the capacity for divergencies from law (p. 85), for it seems incompatible with the requisites of scientific psychology.

PEIRCE defined the business of metaphysics as the study of the most general features of real objects. As such, the locus of its subject-matter would be particularly man's ordinary experience. But PEIRCE never followed out the method he urged of seizing upon the most generic observational traits. He loved too much the dialectical elaboration of ideas into strange bye-paths, and his pretence of scientific candor is a dubious counterpoise to the lack of significance consequent to his uncontrolled reasoning. Perhaps it was his initial separation of the practical from the scientific man which foreshadowed the collapse of his metaphysical analysis. For he thus sinned against his own doctrine of continuity, and arbitrarily limited the practical man to adherence to a narrow doctrine concerning practice (p. 2-3). PEIRCE had forgotten that the theologians against whom he inveighed were confuted through efforts inspired largely by practical motives. Practice, in a truly practical spirit, can grow and take many forms, and one of these, indeed, is scientific logic itself.

Cambridge, Massachusetts. LEWIS S. FEUER.

E. M. Butler.—*The tyranny of Greece over Germany.* ix+351 pp. Cambridge: At the University Press; New York: The MACMILLAN Co., 1935, $4.25.

Miss BUTLER's book, we are told in the words of her subtitle, is devoted to *A Study of the influence exercised by Greek art and poetry over the great German writers of the eighteenth, nineteenth and twentieth centuries.* The writers considered are WINCKELMANN, LESSING, HERDER, GOETHE, SCHILLER, HÖLDERLIN, HEINE, SCHLIEMANN, NIETZSCHE, SPITTELER, and STEFAN GEORGE. With the exception of the last named writer the author claims to contribute no new facts concerning the lives of any of these men, and one has but to read the first few pages of her book to discover that she is concerned not so much with the analysis of the Greek influences upon their writings as with the analysis of the temperamental reactions of these men to those influences and of the effects of this original influence upon their lives, of which their writings were but a secondary expression. For historians of science Miss BUTLER's book is of interest because it deals with an aspect of humanism which stands in the direct line of succession of what we all too consciously speak of as the Modern Age.

In Germany the Renaissance expressed itself in that great movement of liberation, the Reformation which, by divesting religion of so many of its mythological elements cleared the way for a more purely rational

interpretation of the world. In this lay LUTHER's great achievement. But by " depriving the Germans of Roman Catholicism, LUTHER took from them a system which had nourished their mysticism and ministered to their sense of beauty, whilst commanding their belief. In a word, he destroyed the mythological element of Christianity, that poetical combination of beauty and truth for which they have ever since been seeking in Greek or Nordic mythologies or by reverting to the Catholic faith " (p. 4). The emotional aridity of German literature which followed the Reformation ended only with WINCKELMAN's discovery of an absolute standard of beauty in the so-called aesthetic perfection of the art of the Greeks, a discovery with which the Germans have been preoccupied from that day to this. Miss BUTLER's book deals with the vicissitudes through which this new *Weltanschauung* subsequently passed as exhibited in the lives and writings of the great writers whom she has selected for her study. Obviously such a study must remain unsatisfactory so long as these men and their works are considered apart from the multiplicity of influences which were acting upon them anterior to and contemporaneously with this single influence with which Miss BUTLER is alone concerned, and this I find to be the major defect of her book. Cultural processes and events must be studied in the framework of the culture within which they operate, else they appear as so many autochthonous isolates, and no cultural process or event is ever that. From a reading of Miss BUTLER's book one would gain the impression that the birth of the Classical Movement in Germany was almost the only significant thing that occurred there after the Reformation, although, of course, she has no intention of conveying such an impression. Indeed, she is fully alive to the fact that since she is " concentrating almost entirely on an aspect of lives and minds which had innumerable other facets, a certain stylisation has been inevitable; and the whole, in reality an extremely complex subject, appears in simplified outlines. I can claim only " she adds " to shed some light on the German temperament or at least to have tried to do so." It is to be feared, however, that Miss BUTLER has met with the sort of success which falls to all those who attempt by partial means to throw light upon an inseparable portion of an unanalysed whole. By such a means any sort of subjective interpretation is possible, and though the reader may feel that Miss BUTLER is more often right than wrong in her analyses, he is perforce limited to feeling this and not to thinking it, and this is not altogether comfortable.

But when this has been said it must also be said that within the narrow limits indicated Miss BUTLER has succeeded in presenting an extremely well written account of an important movement as seen through the lives

of the men who contributed to its making. Why the book was ever given the rather broad title it bears it is difficult to see.

New York University. M. F. ASHLEY-MONTAGU.

The collected works of George Abram Miller.—Volume I. University of Illinois, Urbana, Illinois, 1935.

The University of Illinois by its initiative and generosity in making available the collected works of Professor MILLER has rendered an important service to mathematics and has at the same time honored a distinguished member of its faculty. This first volume contains Professor's MILLER's earlier contributions to group theory " together with three papers written for this volume to show the place of this work in the theory and to give a brief survey of the historical development of the subject up to 1900."

There are fifty-nine papers in the volume besides the three to which reference has just been made. Practically all of them deal with permutation groups and abstract groups of finite order. From them one can obtain a good idea of the extent of Professor MILLER's contributions to the subject. They will doubtless receive attention from the journals that review technical mathematical works.

As to the three additional papers, there is a striking difference between them on the one hand and general histories of mathematics on the other; such, for example, as SMITH and GINSBERG's " History of Mathematics in America before 1900." The one concerns itself with a rather small sub-division and treats the development of the fundamental ideas in great detail, while the other gives a more sketchy and general account of a large field. This is inherent in the different purposes of the undertakings, as pointed out by the authors of the latter book in their preface.

Professor MILLER has a remarkable command of the details of the subjects treated in this volume, and he handles these details with the ease and skill of a master. It is therefore with great interest that one follows the narrative in the last paper as the author traces the emergence and development of the basic ideas of the theory. In the first place we have the very notion of a group. The early writers discussed what we now call groups without stating precisely what they had in mind. Obviously they were thinking of a set of elements that is closed under what would now be described as multiplication. But they did not always make it clear whether the associative law was assumed, or not; nor whether the inverse of every element was assumed to be present. There was no generally accepted name for what is now universally called a group until the early part of the nineteenth century, and there was

no postulational definition of the thing discussed until about the middle of the century.

But the richness of detail which characterises the work is definitely limited to the particular fields referred to. There is nothing comparable in regard to groups of infinite order in general, or continuous groups in particular. The historical papers contain no reference to the important subject of linear groups. The index contains only one entry on this subject for the whole volume and that refers to a statement in the " Report on Recent Progress in the Theory of Groups of a Finite Order." FROBENIUS' theory of group characters, which appeared toward the close of the period covered by the volume, is entirely ignored. This is all the more surprising in view of the prominent place given to this subject in a number of books that have appeared since 1900, and especially in view of the importance attached to this theory in modern quantum mechanics (1).

It is perfectly clear what Professor MILLER had in mind, and therefore this is not a criticism beyond the point of indicating that the purpose stated in the preface and quoted in the first paragraph of this review has not been fully realized. A treatment of the neglected subjects comparable with that given to the others would have added greatly to the value of the volume.

W. BENJAMIN FITE.

Arnošt Dittrich.—*Zrozeni astronomie* (Das Entstehen der Astronomie). 142 p. (Herausgeber : Staatliches Observatorium, Stará Ďala, Slovensko). 1935.

Der Verfasser (Direktor des Staatlichen Observatoriums in Stará Ďala) bringt eine interessante und gründliche Untersuchung über den Ursprung und die ältesten Kenntnisse der Astronomie bei Völkern der prähistorischen Ära.

In den ältesten Zeiten ist Meteorologie und Astronomie verquickt. Der Verfasser führt die ältesten Quellen aus der ägyptischen Geschichte über Sonnenfinsternisse und deren astrologische Interpretation an. Ebenso berichtet er über die Kenntnis von Sonnen- und Mondfinsternissen unter anderem in der ältesten griechischen, chinesischen und babylonischen Literatur.

Er führt als älteste Quelle unserer Kenntnis über die Orientierung der Himmelsrichtungen bei den prähistorischen Völkern die Lage der

(1) See, for example, H. WEYL, *Gruppentheorie und Quantenmechanik*, Leipzig, 1928.

Gräber an. Für die Babylonier war beim Städtebau die Orientierung nach Windrichtungen wichtig. Dann untersucht er die älteste Anwendung der Zeiteinteilung während eines Tages mit Hilfe der Sonne.

Als wichtige Quelle über Schifffahrt und Orientierung behandelt er HOMERS Odyssee und weiters den ältesten Gebrauch der Magnetnadel als Kompass bei den Chinesen.

Im nächsten Kapitel geht der Verfasser der Bedeutung der Namen von Sternbildern, hauptsächlich der Benennung nach Tieren, historisch nach, dann der ersten Erkenntnis des Zusammenhangs von Sternen und dem Feuer.

Weiters behandelt er Sternbeobachtung und Zeitbestimmung bei Völkern auf einer niedrigen Kulturstufe, wie Buschmännern und Pygmäen. Es folgt eine Beschreibung und Erklärung der Assoziationen von Sternbildern und Tieren bei primitiven Völkern.

Das folgende Kapitel beschäftigt sich eingehend mit der ältesten Kenntnis von den Sternbildern des grossen und kleinen Bären bei den Indern und Griechen und andern Völkern und dem Winterschlaf und Lebensgewohnheiten von Bären in verschiedenen Zonen. An Hand der ältesten Quellen der Geschichte geht er der Bedeutung nach, die Bären im Leben und Kult der Völker spielten. Dann folgt eine ähnliche historische Untersuchung über die Benennung des Siebengestirnes als Wagen und überdies der Hinweis auf die Mannigfaltigkeit der Benennung, die dieses Gestirn bei verschiedenen Völkern erfahren hat.

Die Rolle der Venus und ihrer Konstellation in Mythen und dem Aberglauben historischer und prähistorischer Völker ist das Objekt des nächsten Kapitels. Der Verfasser führt interessante Daten bei Indianern, Mexikanern, Mohammedanern, Madjaren, Germanen, Babyloniern, Majas, Inkas und Peruanern an. Er geht der Bedeutung der achtjährigen Periode der Venus für die Zeitbestimmung nach. Eine ähnliche Betrachtung folgt über die Fixsterne, Jupiter, die Planetenbewegung und die Zeitbestimmung mit Hilfe ihrer Beobachtung.

Als Fussnoten zum Text führt der Verfasser viele interessante Quellen an, die dem Leser der populären Abhandlung den Weg zum weitern Studium weisen.

(Belmont, Mass.) RUTH RAMLER STRUIK.

Cornelis de Waard.—*L'expérience barométrique, ses antécédents et ses explications. Etude historique.* 198 p. Thouars (Deux-Sèvres), Imprimerie nouvelle, 1936.

L'auteur de cet ouvrage aussi important que modeste est bien connu des historiens de la géographie par son livre sur l'expédition de CORNELIS EVERTSEN le jeune en 1672-1674 (1928; *Isis* 13, 180) et des historiens

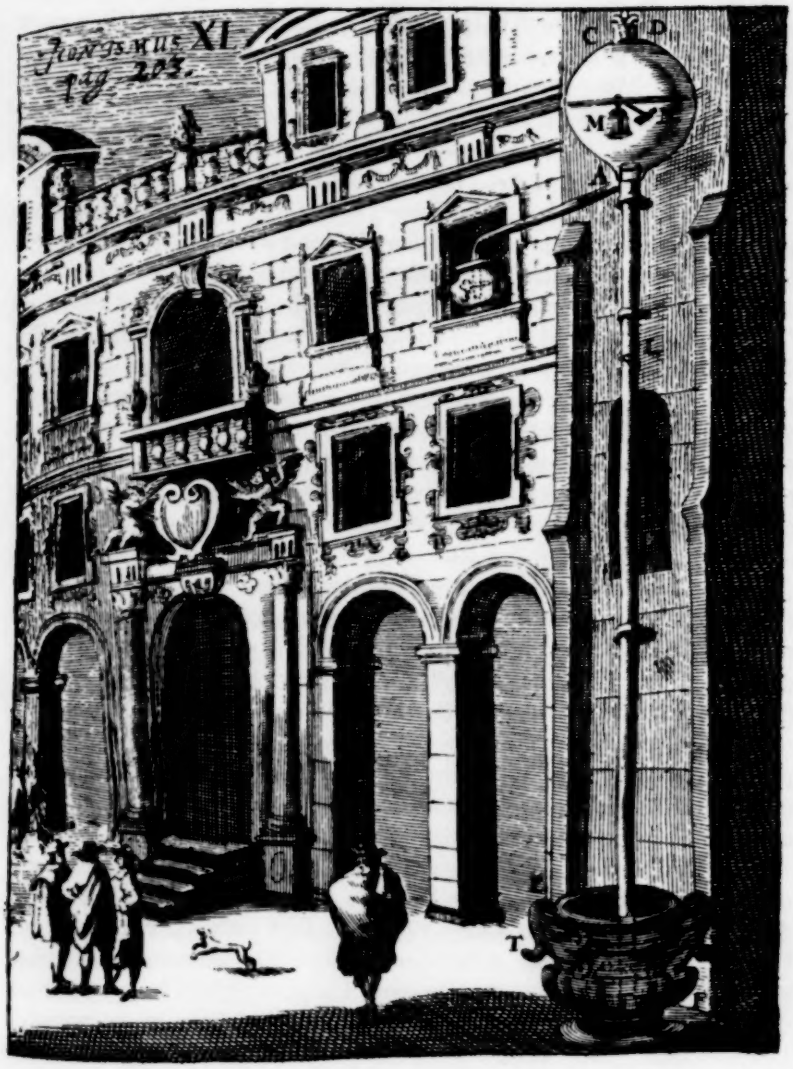
de la physique par de nombreuses études sur la préhistoire du thermomètre, sur BONAVENTURA CAVALIERI, TORRICELLI, ROBERVAL, MERSENNE, PIERRE PETIT (*Isis* 8, 555), DESCARTES, etc. On voit qu'il s'est surtout intéressé à la science du XVII^e siècle. Depuis des années il s'est occupé à préparer deux œuvres considérables, d'une part la *Correspondance du P.* MARIN MERSENNE, en collaboration avec Mme. PAUL TANNERY, dont le premier volume a paru en 1933 (*Isis* 20, 467-70), d'autre part le *Journal d'*ISAAC BEECKMAN, dont il a bien voulu entretenir lui-même nos lecteurs (*Isis* 24, 123-5, 1935).

ISAAC BEECKMAN (né à Middelbourg en 1588, mort à Dordrecht en 1637) (1) est un de ces hommes dont le génie n'a pas reçu les éloges mérités parce qu'il n'a rien publié. Même sa thèse de doctorat à l'université de Caen (*De febre tertiana intermittente*, Cadomi, 1618), ne paraît pas avoir été publiée en entier. M. DE WAARD nous donne (p. 78-79) des fac-similés de la première et dernière page de l'exemplaire du British Museum, mais il ne nous dit pas que ces pages sont les seules qui existent.

N'y a-t-il nulle part ailleurs un exemplaire complet? Et sinon, ne peut-on supposer que la publication en fut restreinte à ces deux pages *pro forma?* En d'autres termes cette publication n'en est pas une. Il ne suffit pas qu'un savant annonce ses conclusions, il faut qu'il les prouve, ou tout au moins qu'il les justifie. Ce n'est que lorsque le Journal de BEECKMAN sera intégralement publié qu'il sera possible d'apprécier équitablement son génie. Et de toutes manières, comme je l'ai remarqué plusieurs fois au sujet de LEONARDO DA VINCI, si un savant n'est pas capable de faire les efforts nécessaires pour la publication de ses découvertes, il ne mérite pas d'être loué comme s'il avait eu les qualités nécessaires pour cela. Le principal obstacle à la publication, ce n'est pas en général le manque d'argent ou d'autres circonstances matérielles, mais plutôt l'absence d'un manuscrit où les découvertes soient expliquées d'une manière complète et méthodique.

Cette parenthèse m'éloigne moins de mon sujet ou plutôt du sujet de M. DE WAARD qu'elle n'en a l'air, car ce sont les notes de BEECKMAN dans son Journal qui ont amené l'auteur à faire cette vaste enquête sur l'expérience barométrique, et de fil en aiguille, sur les idées des philosophes de l'antiquité et du moyen âge concernant le plein et le vide, la pesanteur de l'air, l'attraction, l'horreur du vide, l'antipéristase, et la pression hydrostatique. Mon énumération rapide vous donne une idée de la complexité de la question. Les manuels élémentaires d'histoire de la

(1) La meilleure biographie de lui que je connaisse est celle que DE WAARD lui-même a écrite pour le *Nieuw Nederlandsch Biografisch Woordenboek* (vol. 7, 84-88, 1927).



BERTI's experiment after G. SCHOTT:
Technica curiosa, 1664 (Courtesy of Mass. Inst. of Tech.)

physique où l'expérience de TORRICELLI est brièvement décrite nous cachent cette complexité et ne nous la laissent même pas deviner. A vrai dire celle-ci est si grande que l'étude de M. DE WAARD est fort touffue et parfois un peu difficile à lire; je n'essaierai donc pas de la résumer.

Il suffira ici d'indiquer les points principaux établis par l'auteur. Dès 1615 BEECKMAN avait noté que l'action des pompes résultait de la pression de l'air, et il n'hésita point a " publier " cette opinion dans sa thèse de 1618 " Aqua suctu sublata non attrahitur vi vacui sed ab aere incumbente in locum vacuum impellitur." On pourrait donc dire que l'expérience barométrique avait déjà été faite par lui implicitement dès 1615. Cependant il ne fit pas d'expérience explicite *ad hoc*, et GIOVANNI BATTISTA BALIANI (1586-1666) à qui la priorité en est parfois attribuée ne la fit pas davantage (en 1630). Dans ses *Discorsi e dimostrazioni matematiche* (Leyden, 1638), GALILEO rapporta le propos d'un ouvrier qui lui dit qu'il était impossible d'élever l'eau dans une pompe au-dessus de dix huit coudées. Cette remarque suggéra sans doute la première expérience barométrique, qui ne fut pas l'expérience torricellienne réalisée par VINCENZO VIVIANI à Florence en 1643, mais une expérience différente faite par GASPARO BERTI (ou ALBERTI, mort en 1643) à Rome vers 1640 (2). L'appareil de BERTI était une sorte de pompe modifiée, attachée à la façade de sa maison, dont un dessin (que nous reproduisons) parut plus tard dans les *Technica curiosa* du Jésuite allemand GASPAR SCHOTT (1608-66), ouvrage publié en 1664, non pas à Würzburg comme le dit DE WAARD (p. 104), mais à Nuremberg. L'expérience de BERTI provoqua de longues discussions; l'expérience de TORRICELLI, plus pratique, en fut une conséquence.

Tout cela est non seulement expliqué avec beaucoup de détails et une grande précision, mais de plus l'auteur a ajouté en appendice le texte intégral de tous les documents justificatifs : extraits du Journal de BEECKMAN (p. 145-69), et de lettres et livres contemporains.

Le seul défaut de cet ouvrage, à tous autres égards si consciencieux, c'est l'absence d'un index. Ce manque de charité est déplorable, et d'autant plus que l'œuvre est plus belle.

GEORGE SARTON.

E. A. Milne.—*Relativity, Gravitation and World-structure.* VIII+365 p. Oxford University Press, 1935. (Price $8.00).

When one looks at the hundreds of pages which comprise the *Théorie analytique de probabilités* of P. S. LAPLACE, he cannot reflect without

(2) En tous cas avant la mort de GALILEO (8 janvier 1642).

amazement that all these pages with their complex array of formulas have been derived from one very simple definition, namely, that if an event can happen in m ways and fail to happen in n ways, and if each of these ways is equally likely, then the probability that the event will happen is $m/(m + n)$. One has something of the same feeling of astonishment when he regards the large book before us for review and reflects that it is largely inspired by a single experimental observation, namely, that the lines in the spectra of the spiral nebulae are shifted toward the red, and that this shift is directly proportional to the distances of the nebulae from us. This beautiful discovery is known as HUBBLE's law after its discoverer, Dr. EDWIN HUBBLE of the Mount Wilson Observatory, and may be more precisely stated thus: The DOPPLER shift in the spectra of the nebulae is equivalent to a recessive velocity of 500 km. per sec. for every 10^6 parsecs of distance (1 parsec = 3.258 light years).

Attempts to interpret this remarkable cosmic phenomenon have led to a new branch of astrophysics, which may be called the cosmological theory of relativity. The theory of relativity has been applied rather loosely to three separate, although intimitely connected propositions. The first of these is the so-called special theory of relativity, which now seems to be too firmly rooted in experiment to be successfully challenged. This theory originated in the MICHELSON-MORLEY experiment, which failed to detect a postulated motion of the earth through the ether. The second of these was the gravitational theory of relativity, a proposition which attempted to transfer the innate gravitation of ponderable bodies according to the Newtonian postulate to the geometrical characteristics of space as influenced by contiguous matter. The verification of the two spectacular predictions of EINSTEIN (the bending of light in the gravitational field of the sun and the gravitational shift of the spectrum in heavy stars), together with the successful explanation of the anomalous behaviour of the perihelion of Mercury, has erected a strong fortress around this proposition. The third or cosmological theory of relativity has concerned itself with the general problem of the macro-structure of space-time and the distribution of matter within it.

The brilliant speculations engendered by the cosmological problem have assumed several forms, which proceed from rather widely separated postulates. EINSTEIN, following a suggestion of E. MACH, has attacked the problem from reflections on the origin of inertia. This he attributed to the distribution of mass in the universe and hence was led to a RIEMANN space of positive curvature, which permitted light to make the circuit of space. The main argument against this proposition was the lack of sufficient matter in the universe as it was known at the time when

EINSTEIN advanced his theory. This defect, however, was spectacularly removed by the discovery of the true nature of the spiral nebulae, namely, that they are stellar galaxies. DE SITTER, on the other hand, conceived a space of negative curvature, which imposed a " wall of time " beyond which light could not go (from our position of observation), and this theory admirably explained the recessive shift of the nebular spectra. The third phase of explanation proceeded from FRIEDMANN and LEMAÎTRE, who independently advanced the idea that the DOPPLER shift was a measure of a real recession and that the radius of the universe was increasing with time.

With these various theories and postulates before him, the author of the present volume undertook the cosmological problem *ab initio* and his preliminary investigations were published in a 95-page monograph in the *Zeitschrift für Astrophysik*, vol. 6 (1933). The success of these ideas led him to essay the present volume, which correlates his own investigations with those of others in a more systematic manner than was possible in the earlier work.

The present book is divided into four parts : I. Kinematics and Relativity; II. Kinematic World-Models. III. The Career of the Universe. IV. World Pictures. This volume as well as the entire literature of the subject, is replete with suggestive and picturesque phrases, doubtless occasioned by the highly imaginative character of the problem.

The author begins with EINSTEIN's cosmological principle, which he describes as follows : " We shall therefore say that two particle-observers A and B are equivalent when the totality of observations A can make on B can be described by A in the same way as the totality of observations which B can make on A can be described by B. When this condition is satisfied, we shall write $A = B$. A system of particles is then said to satisfy EINSTEIN' cosmological principle when if A and B are two members of the system such that $A = B$, then A's description of the whole system is identical with B's description of the whole system."

By means of this very simple proposition, from which the well known LORENTZ transformation is derived as " an immediate consequence of the equivalence of two observers A and B who find themselves in ' uniform relative motion,' " the author proceeds to explore the kinematics of the universe.

Perhaps the key with which the author attempts to unlock the mysteries of space is fully epitomized by the following conclusion which is immediately reached through the cosmological principle : " The phenomenon that if two observers in uniform relative motion send out an expanding light wave, each will for ever see himself as the center of

the spherical wave, in his own reckoning. In our system each uniformly moving particle-observer of the system sees himself for all time as the center of the system, and sees the system arranged non-homogeneously but with spherical symmetry round himself."

One of the most intriguing things about the book is the fact that the author has been able to squeeze so many results out of such a simple postulate. In this book we find none of the complicated machinery of the tensor calculus and differential geometry, but these tools are replaced by the comparatively simple analytical devices suggested by the LORENTZ transformation. Let us add, however, that the mathematician will find much to interest him in the formal manipulation of equations and in the extraordinary ingenuity of the author in employing the formulas which the development of the contents of his postulate has suggested.

The book is filled with picturesque phrases and the engaging word pictures which this romantic subject has naturally engendered. Many interesting conclusions are deduced by the author. Thus we find him answering the question: Is nature infinite? with the remark: " Rejecting, in common with all other investigators, the ' island universe ' theory, we are driven to the conclusion that the universe cannot contain a finite number of objects. Hence it must contain an infinite number."

The author is not afraid to test his theory by prediction and in one place he sets forth 14 characteristics of the distribution of the spiral nebulae, characteristics which are presumably capable of experimental verification when the new 200-inch telescope, or some larger telescope of the future, is directed to the problem. Among these conclusions we find such propositions as these: " The total number of nebulae is infinite," " the recession velocities range up to c (the velocity of light)," " the distance of any nebula is less than ct," " the density tends to become indefinitely great at the distance ct," " the nebulae at distances just less than ct are almost invisible," and " nebulae at great distances should show a strong Lorentz contraction in the line of sight."

It is impossible in a brief review to give more than a small account of the riches which await a reader who will take the time to read patiently and thoughtfully the pages of this interesting volume. The Oxford Press is to be congratulated on adding so stimulating a book to the literature of cosmic astronomy. It is beautifully printed and belongs to the *International Series of Monographs on Physics*, produced under the general editorial direction of R. H. FOWLER and P. KAPITZA.

Indiana University. H. T. DAVIS.

Percy Brown.—*American Martyrs to Science Through the Roentgen Rays.* XV+276. CHARLES C. THOMAS, Springfield, Ill., 1936 ($3.50)

One woman and twenty-seven men of American nationality who died as a result of their devotion to their work in connection with roentgenology are here finely memorialized by one of the leading figures in American roentgenology, Dr. PERCY BROWN. It is in the sense of suffering and death as a consequence of devotion to a cause that Dr. BROWN uses the term *martyr*, and in this sense the application of the term to the men and women who figure in the pages of this book is quite unobjectionable, though it may, perhaps, be felt that it would have been more in keeping with the spirit of these victims of their work had a less emotionally charged epithet been applied to them. When, however, in the light of their great contributions to the cause of humanity, one reads of the sufferings of these men and women and of the courage with which those sufferings were borne the feeling grows on one that *martyr* is an epithet totally inadequate to describe what all these men and women actually represented. Not one of them seems ever to have realized what the effects of their work were likely to be upon themselves, and the pursuit of their labours were carried on with an enthusiasm completely innocent of any notion of its dangerous character. When the effects of continued exposure to the Roentgen-Rays began to manifest themselves, it was generally too late. The course of the declared disease was invariably attended with the most painful sensations, and its development was such as to necessitate recourse to repeated operative procedures which, however, in the case of these twenty-eight American men and women, failed to give more than a relief that was momentary, the final relief came only with death.

Of these twenty-eight pioneers it is of interest to note that eleven were not medically qualified, and that at least six of these were technicians who helped to devise the instruments which afterwards came into common use.

It was in December 1895 that ROENTGEN's *Preliminary Communication* appeared. Ten weeks later F. BATTELLI, in an article entitled "The Reaction of Roentgen-Rays upon various Human Tissues" (*Atti. Acad. Med. Fis. Fiorent.*, 14 Mar. 1896) sounded what should have served as the first warning of the dangers of the new discovery. In the same year H. D. HAWKS, a student in the Department of Physics at Columbia University, published a detailed account of the manifold skin injuries suffered by himself as a result of exposure to Roentgen-Rays (*Electrical Engineer*, N. Y., 22:276, 1896). Somewhat later in the same year Professor ELIHU THOMSON published an account of an experiment performed on himself (*Electrical World*, N. Y., 28:766, 1896; *Electrical*

Engineer, N. Y., 22:520 & 534, 1896) in which the little finger of his left hand had been exposed to the Roentgen-Rays. The painful and now well-known changes produced in this finger led THOMSON to conclude that " There is only the supposition left that the effect was produced by Roentgen-rays or something that comes from Roentgen-rays..." " There is evidently " he remarked " a point beyond which exposure cannot go without causing serious trouble." There were others who also repeatedly urged the necessity of taking precautions in the use of these rays, and WILLIAM ROLLINS, as early as 1898 constructed a non-radiable box with a diaphragmal aperture for the purpose of enclosing the focus-tube and thus preventing the scattering of its emanations.

The evidence seems to be such that it is almost certain that most of these early workers were unacquainted with the warnings which had been issued by their immediate predecessors, and in some cases their contemporaries, for from the accounts given by Dr. BROWN of their personalities it seems clear that they would, had they have been aware of the danger to which they were exposing themselves, have taken all reasonable precautions to safeguard themselves as well as others. There is evidence that only one of these workers, W. C. EGEHOFF, actually disregarded the warnings given him by others and by his own symptoms. Within four years, at the early age of thirty-five, he was dead.

Apparently the various articles which were written and published in order to sound the alarm of danger never reached these workers until by their own tragic examples they were able to make their existence and their significance aware to others. It is a tragic story, and Dr. BROWN has told it impressively.

New York University. M. F. ASHLEY-MONTAGU.

John Scott Haldane (1860-1936).—*The Philosophy of a Biologist.* XII+155 p. Oxford University Press, 1935. (Price $2.50).

This book sets forth the philosophical conclusions of a man, too well known to require a biographical introduction, who has devoted his life to biological science from a cultural background of Hegelian and Kantian idealism. The present volume of reflections is unusually stimulating and covers more ground than one might infer from the small number of pages.

The book consists of an introduction, a retrospect, and four chapters : I. Philosophy and Physical Science. II. Philosophy and Biology. III. Philosophy and Psychology. IV. Philosophy and Religion.

The author begins with an apologia for philosophy and affirms that this discipline, in spite of its ever changing form and its destructive criticism of predecessors, belongs to the same category as science. " When

new light is thrown on the general ideas previously held in any branch of science the old ideas are not destroyed, but only developed into a form which is more consistent with experience." Because of this kinship he believes that " apart from the sciences there would be no philosophy".

The point of view of the author is neither that of materialism nor spiritual idealism as he shows in his discussion of the contributions of DESCARTES, SPINOZA, LOCKE, BERKELEY, and HUME to the history of thought. He indicated that the philosophy of DESCARTES had tended toward materialism and this may perhaps account for the extraordinary statement that the development of mathematics " had but little to do with modern philosophy."

Proceeding to the philosophies of KANT, FICHTE, SCHELLING and HEGEL, the author showed how the concept of the " absolute " came to play a part both in Kantian and post-Kantian systems. Hence the doctrine of relativity was beyond the scope of these philosophies, althoug one may conclude that " for EINSTEIN, as for KANT, the physical universe is essentially a unified universe, nothing being self-existent. In this sense, modern physics may be said to have become idealistic, although as with post-Kantian philosophy, not in the sense that the universe as perceived depends on any mere individual percipient." The author's general philosophical point of view may be characterized as a kind of modified Berkelianism as one may gather from his conclusion that " the whole world of physical experience is a world of perceived experience, and non-existent apart from perception, though not mere individual perception."

When the author, as a biologist, discusses the actual problems of biology, his conclusions are particularly interesting. After tracing the history of vitalism from STAHL (1660-1734) with his phlogiston theory down to the " entelechy " of DRIESCH, he says : " When one considers the nature of the facts which embryology discloses, and the futility of all attempts at a physico-chemical interpretation of these facts, it certainly seems at first sight as if we were driven backward toward vitalism." At this point one regrets exceedingly that the author did not have the opportunity to discuss the recent revolutionary discoveries of Dr. HANS SPEMANN, recent Nobel prize winner. The work of SPEMANN and his school apparently shows that the integration process in embryology, which DRIESCH attributes to the entelechy, can be traced to its biochemical equivalent. The factual arguments now seem to incline to the side opposing vitalism, although one would be rash indeed to assume that the great controversy is finally closed.

The author opposes vitalism on other grounds, a principal objection being that materialism was accepted by the vitalist outside the body,

but not inside. " We cannot separate in space the phenomena of life from those of its (the organism's) environment." In such statements as : " In what we see around us, we ourselves are always present;" " The oppression produced by the idea of a perceived world in which we have no part disappears," and " There is no spacial separation between the lives of different organisms," the author clearly shows that he belongs to the monistic school of philosophy. The problem of a dualism in nature, the necessity of differentiation between the " subjective " and the " objective," find no place in his system of thought. He perceives only a complete and coördinated nature in which the principle of relativity replaces the dichotomy of dualistic philosophy. Vitalism, as it is understood in its technical sense, is replaced by this more non-materialistic postulate, and the author avers that " life is from its very nature incapable of being described or understood in terms of mere physical conception." In pursuing his argument he goes so far as to say that " we come to realize, moreover, that apart from their co-ordination and maintenance biophysical and biochemical phenomena are devoid of interest to biologists."

In order to strengthen his defense of a relativistic biology, the author appeals to the discoveries of physical science and quotes PLANCK to the effect that " the concept of wholeness must therefore be introduced in physics as in biology." He is naturally led to the extreme generalization " that life... must be regarded as ultimately inherent in what we at present picture as inorganic phenomena, and that it is only for practical reasons with present knowledge that we are compelled to separate organic from inorganic phenomena."

This same thread of the unity of nature pervades the author's view of psychology, a subject which he thought, in the history of philosophy, " fell between the two stools of mechanistic biology and an abstract idealism represented in the conception of a soul independent of its body." His thesis is neither modified nor extended by a review of the phenomena of psychology. The chapter is worth reading, however, for the one sentence : " Memory is like an immense encyclopedia with the magic property of always opening at the right place and telling us the spatial, temporal, and other relationships of what participates in our interest, including future events."

It will be clear to the reader that the philosophical postulates of the author tend toward religious orthodoxy. For him the universe, because of its unity both inside and outside of living matter, must be dominated by a single principle. This unity is found in personality and he says that " the conception of truth, whether relative or ultimate, presupposes a world of one personality." For him " the conceptions of matter

and energy... depend on what is found to remain constant in presence of what are and remain otherwise fleeting appearances. The conception of life depends, in its application, on the co-ordination which is found to persist amidst what are otherwise chaotic physical and chemical phenomena." The fact that the universe is not essentially chaotic implies for the author the dominance of a unifying personality.

The book concludes with a discussion of the concept of beauty, which is for the author the supreme principle in ethics and aesthetics. His views on this are fully epitomized by the dictum of KEATS : " ' Beauty is truth, truth beauty,'—that is all ye know on earth, and all ye need to know."

From this brief résumé of the contents of Professor HALDANE's book, it will be seen that anyone interested in speculation about the meaning of mysterious nature will find much to engage his thought.

(Indiana University.) H. T. DAVIS.

Arlindo Camilo Monteiro.—*Da fitologia sacra.* Contribução histórica para o estudo da botânica, da terapêutica e da etnografia. 140 p., pl. Edição do autor (no place, presumably Lisboa), 1934.

The intriguing title " Da Fitologia Sacra " by ARLINDO CAMILO MONTEIRO aroused hopes of a feast of curious information which a perusal of the work failed fully to gratify. One expected to find interesting anecdotes, relating how certain plants became associated with the name of a saint or some such pious tradition. Instead of which we find a total of some fifty plants with a hagiographical name, each with a long list of synonyms, their botanical characteristics and use in therapeutics. Thus we have : God's grace, Herb of the Trinity, Root of the Holy Spirit, The Sacred Herb, Christ's palm, Christ's eye, Herb of St. Mary, St. Mary's rose, and herbs named after Saints Albert, John, Peter, Philip, Anthony, James, Francis, Barbara, Joseph, Christopher, Catherine, Lucy, Mark, Bartholomew, Gregory and so on. In some instances the associated sanctity has come down to us from pagan times. Verbena, for example, an Erva Sagrada was known as Hierobotane in the works of PLINY and SCRIBONIUS LARGUS. On solemn occasions, such as on the declaration of war, the high priest, Pater Patratus, was crowned with verbena leaves.

The list of saints whose names have been linked with botanical lore is by no means complete, such well known names as St. Ignatius' bean and St. Patrick's cabbage and several others are missing. The author, however, does not claim to present an unabridged account because, as he tells us, his work is based upon the 17th century publication of DUVAL's " Historia Monogramma sive Pictura Linearis Sanctorum Medicorum et Medicarum."

It is interesting to note that the plant whose leaves produce tobacco was called the Herba Sancta of Duval, following PETRUS PENA, who gave the name Erva Santa because it was supposed that the smoke from the burning leaves had miraculous efficacy in pulmonary diseases.

Although the name of JEAN NICOT is indissolubly associated with tobacco (Nicotiana Tabacum), and he is credited by J. RAY in his Historia Plantarum as being the first to introduce the plant into France under the name ' herbe à la reine ' or ' herb au Grand-Prieur,' the author claims that the Portuguese were the first to cultivate this plant in Europe. Priority is claimed for GABRIEL SOAVES DE SOUSA (1540-1591) whose work " Descripção Geographica da America Portugueza " was not printed until the 19th century.

Reproductions of the title pages of two very early and curious works on tobacco are among the illustrations. The earliest printed in London in 1570 by PETRUS PENA and MATHIAS DE LOBEL is entitled " Stirpium Adversaria Nova &c," the second " Tabacologia hoc est Tabaci seu Nicotianae descriptio &c " by JOHANNES NEANDER of Bremen, printed at Leyden by ELZEVIR 1626.

Enthusiasts for tobacco will endorse the epigram of JOHANNES PORTHIUS

" Nulla salutifera se comparet herba Tabaco
Viribus haec omnes exsuperat reliquas."

An interesting account is given of the introduction of tea into the West. According to DUVAL this is also a sacred plant, Erva Divina or Theobotane. Its name Thé according to a strange philology is obviously derived from Theos !

(Toronto.) PAUL M. O'SULLIVAN.

Fritz Schmidt.—*Geschichte der geodätischen Instrumente und Verfahren im Altertum und Mittelalter.* (Veröffentlichungen der Pfälzischen Gesellschaft zur Förderung der Wissenschaften, Band XXIV), Neustadt an der Haardt, Verlag : Pfälzische Gesellschaft zur Förderung der Wissenschaften, 1935. 400 S. und XXVI Tafeln.

Das zur Besprechung vorliegende Werk soll, gemäss der vom Verfasser in der Einleitung gegebenen Definition, einen Überblick über die Geschichte aller wichtigen Instrumente der praktischen Geometrie und ihrer Anwendungen, mit Ausschluss der Astronomie und der geometrischen Konstruktionen, von den ältesten Zeiten bis zum Ende des Mittelalters, geben. Diese Instrumente werden zusammenfassend als " *geodätische* " bezeichnet, wobei unter " Geodäsie," nach dem bis zum Beginn der Neuzeit herrschenden Gebrauch, in der Hauptsache die Feldmessung verstanden wird, einschliesslich des Nivellierens, sowie der in der Baukunst und im Kriegswesen vorkommenden Messungen.

Die Gebiete der Landesaufnahme zur Kartenanlage und der Vermessung des Erdkörpers, die in dem betrachteten Zeitraum allerdings wenig entwickelt sind, sollen ebenfalls einbegriffen sein. Eine Geschichte der Zeichen- und Konstruktionsinstrumente, für die sich schon aus den zur Abfassung des vorliegenden Werkes benützten Schriften vieles entnehmen liess, ist als Ergänzung vorgesehen.

Eine Gesamtdarstellung der Entwicklung der älteren geodätischen Instrumente und Verfahren ist bisher noch nicht geschrieben worden. Die "*Recherches sur les instruments, les méthodes et le dessin topographique*" von A. LAUSSEDAT (Paris, 1898) und die Geschichte der Mathematik von A. G. KÄSTNER ("*Geometrische Abhandlungen, II. Sammlung*," Göttingen, 1791) verlegen den Schwerpunkt auf die Neuzeit und lassen ganze Gruppen von Instrumenten unberücksichtigt. In den Schriften über die Entwicklung der Technik (unter denen speziell die Werke von F. M. FELDHAUS, L. DARMSTÄDTER und H. DIELS hervorzuheben sind) findet die Geodäsie naturgemäss nur auf kleinem Raume Behandlung. Was wir im übrigen an einschlägiger Literatur besitzen, sind vorwiegend Einzeldarstellungen, die den grösseren Zusammenhängen zumeist nur in beschränktem Masse Rechnung tragen. Angesichts dieser Tatsache ist ohne Zweifel dem Versuch, in geschlossener Form eine Behandlung des Gesamtkomplexes der älteren geodätischen Instrumente und Verfahren zu geben, grösste Wichtigkeit beizumessen.

Dr. FRITZ SCHMIDT, der sich dieser mühevollen Arbeit unterzogen hat, hat seine schwierige Aufgabe in glänzender Weise gelöst. Das Werk zeugt von einer ganz erstaunlichen Belesenheit des Verfassers, einem tiefen Verständnis der Materie und nicht zuletzt einem bedeutenden historischen Einfühlungsvermögen. Der kritische Apparat, in annähernd 1400 Fussnoten niedergelegt, dürfte wohl praktisch alles umfassen, was an wichtiger Literatur überhaupt erschienen ist. Diese enorme Anzahl der kritischen Bemerkungen könnte leicht zu der Annahme verleiten, dass das Werk gewissermassen mit Gelehrsamkeit überladen und demzufolge schwer geniessbar sei. Ich möchte jedoch betonen, dass hiervon nicht die Rede sein kann; es ist vielmehr dem Verfasser gelungen, den manchmal doch etwas trockenen oder zum mindesten spröden Stoff in eine elegante und flüssige Form zu kleiden, die die Lektüre durchweg zu einem Vergnügen macht. Die Figuren im Tafelanhang (an Zahl über 350 auf 26 Tafeln) sind hervorragend ausgeführt und ergänzen den Text in idealer Weise.

Der Stoff ist nach dem folgenden Anlageplan logisch gegliedert (vgl. S. 29):

1. Geodätische Urinstrumente, deren Benützung ausser dem Abmessen und Addieren von Längen keinerlei Rechnung erfordert:

a) Nivellierinstrumente,

b) Instrumente zum Antragen rechter Winkel und

c) Längenmesser.

2. Instrumente zur indirekten Streckenbestimmung mittels ähnlicher Dreiecke :

I. Die Dreiecke sind rechtwinklig :

a) Stäbe und Stabverbindungen,

b) Das Schattenquadrat auf dem geometrischen Quadrat, dem Astrolab und dem Quadranten.

II. Die Dreiecke sind teils recht- teils schiefwinklig : Der Jakobsstab.

III. Die Dreiecke sind schiefwinklig : " Triangulationsinstrumente."

3. Winkelmesser :

a) Teilkreise : Astrolab und Quadrant; diese Verwendung der beiden Instrumente wird unter 2 I *b* mitbehandelt.

b) Winkelmesser mit geraden Teilungen : Schmiege und Triquetrum (Der Jakobsstab und das Geometrische Quadrat s.o.).

Als Ergänzung ist gedacht :

4. Die Instrumente zur Anwendung graphischer Verfahren, die *Messtische*.

Die Darstellung erstreckt sich auf die grossen Kulturen des Altertums : Ägypter, Babylonier, Perser, Hebräer, Inder, Chinesen, Griechen, Römer, sowie das islamische und christliche Mittelalter. Durchweg sind die Einzelprobleme mit ausserordentlicher Gründlichkeit und in grösstmöglicher Vollständigkeit behandelt und zu einem einheitlichen Ganzen zusammengefügt. In keinem Falle sieht man sich dazu berechtigt, " Kritik " im üblichen Sinne des Wortes zu üben. Ich möchte daher auch die folgenden Bemerkungen zu einigen Punkten, die mir bei der Lektüre auffielen, ausdrücklich als an sich unwesentlich und die Bedeutung des Werkes in keiner Weise herabsetzend kennzeichnen :

Bei den ägyptischen Normal-Ellenmassstäben (S. 146 f.) ist auffallend die ungenaue Teilung in " Finger " : Die einzelnen Fingerbreiten weichen stark von einander ab, so dass die weiteren Unterteilungen in Halbe, Drittel, Viertel usw. bis Sechzehntel illusorisch erscheinen. Ganz ähnlich verhält es sich mit dem sumerischen Gudea-Massstab, auf dem ungeteilte Fingerbreiten mit sukzessive 6-, 5-, 4-, 3-, 2-fach unterteilten Fingerbreiten alternieren. Es scheint, dass diese Massstäbe—zum mindesten die genannten Unterteilungen—in der Praxis keine Verwendung gefunden haben oder dass sie nur als schematische Vorbilder für die Herstellung genauer, praktisch anwendbarer Massstäbe dienten.

In Abschnitt III 2f (Chinesische Längenmasse) hätten die chinesische " Meile " (Li) und die " Fingerbreite " (Ts'un) neben den " Füssen und Zehnfüssen " (Ch'ih und Chang) Erwähnung finden sollen. Li

und Ts'un spielen bereits im ersten (älteren) Teil des Chou-pi Suan-ching eine bedeutende Rolle. Ebenso sollte in dem vorhergehenden Abschnitt *e*), der den indischen Massen gewidmet ist, das indische " yojana " aufgenommen werden, das speziell in AL-BĪRŪNĪS " Indien " vielfach als Längeneinheit auftritt.

(S. 257) Die Herleitung des in mittelalterlichen Schriften in verschiedenen Schreibweisen auftretenden " Walzacora, Wazalchora, Waztalcora," etc., aus dem arabischen " ***Wazn al-kura*** " (" Abwägen " = " Prüfen " der Kugel) ist wohl ohne Zweifel nicht zutreffend. (Den Stempel noch grösserer Unwahrscheinlichkeit trägt der Erklärungsversuch LYNN THORNDIKE's (in " ***A Study in Magic and Experimental Science***, Vol. I, New York, 1923, S. 699 (Fussnote 6 zu S. 698)) auf Autorität Prof. D. B. MACDONALD's : Waztalcora entstanden aus ar. ***Rasmu-l-kura***, " the describing of the sphere in lines "). Wie schon W. H. MORLEY (***Description of a Planispheric Astrolabe constructed for Sháh Sultán Husain Safawí***, London 1856, S. 5) betont, findet sich in arabischen Schriften zuweilen der Terminus ***Waḍ'at al-kura***, die " Projektion der Himmelskugel ", den das latinisierte "Waztalcora" ganz getreu wiedergibt. Ich habe an anderer Stelle die Vermutung ausgesprochen, dass der arabische Ausdruck eine direkte Übersetzung des ptolemäischen " ἄπλωσις ἐπιφανείας σφαίρας " darstellt.

(S. 265) Das " Astrolab aus dem Jahre 905 " der Bibliothèque Nationale (vgl. SÉDILLOT, Mémoire sur les instruments astronomiques des Arabes, Paris 1844, S. 172) ist heute wohl allgemein als eine im 12. Jahrhundert angefertigte Kopie eines frühen Instrumentes anerkannt. Das älteste im Original erhaltene Astrolab scheint das Instrument der Brüder AḤMAD UND MUḤAMMAD VON IṢFAHĀN, der Söhne des IBRĀHĪM, aus dem Jahre 374 H. = 984 A.D. zu sein, das sich heute in der LEWIS EVANS Collection im Old Ashmolean Museum in Oxford befindet.

(S. 271) Die beiden Bücher " ***De utilitatibus astrolabii***," die dem Werke " ***De mensura astrolabii*** " HERMANNS DES LAHMEN in den drei gedruckten Ausgaben (1. PEZ, ***Thesaurus anecdotorum novissimus***, III, pars II, Augsburg, 1721; 2. MIGNE, ***Patrologia Latina***, CXLIII (1853) und 3. GUNTHER, ***The Astrolabes of the World***, Vol. II) folgen, entstammen nicht der Feder HERMANNS. Das erste Buch, das BUBNOV (***Gerberti opera mathematica***, 1899, S. 109-147) ediert hat, ist eine Übersetzung aus dem Arabischen, die spätestens im 11. Jahrhundert entstand. Das zweite Buch stammt von einem unbekannten Autor; seine Entstehungszeit ist gleichfalls nicht später als das 11. Jahrhundert anzusetzen (vgl. hierzu auch LYNN THORNDIKE, *op. cit.*, Chapter XXX, " GERBERT and the Introduction of Arabic Science.")

Durchweg nicht glücklich gelöst ist die Frage der Transkription

chinesischer Namen und Ausdrücke. Es ist ja häufig genug von den verschiedensten Seiten auf die verwirrende Uneinheitlichkeit hingewiesen worden, die gerade in diesem Punkt in der gesamten europäischen Literatur herrscht. Als mustergültig ist—wofern man gezwungen ist, auf chinesische Typen im Druck zu verzichten—das von G. SARTON in allen seinen Werken adoptierte System zu betrachten, wonach alle chinesischen Wörter in der Wade'schen Transkription und mit den Nummern der 2. Auflage des Chinese-English Dictionary von GILES zitiert werden. Manche der von Dr. SCHMIDT gegebenen Wörter sind durch die Transkriptionen so entstellt, dass sich das chinesische Ideogramm nur mit Schwierigkeit erkennen lässt; in einigen Fällen erscheint es zweifelhaft, welche Zeichen gemeint sind. Es ist unangebracht, veraltete, unsachgemässe Transkriptionen zu adoptieren oder neue zu erfinden, wenn diese nicht einen wirklichen Fortschritt gegenüber den bereits existierenden bedeuten. Die bei SCHMIDT häufig auftretende Schreibweise *Tschīu* (für den Namen der Chou-Dynastie) ist sinnlos, denn sie legt offensichtlich die Betonung auf ein *ī*, das in der Aussprache überhaupt nicht vorhanden ist. Ebensowenig entspricht den Tatsachen die verschiedene Schreibweise von "*lỳ*" und "*pì*" (Tschīu-lỳ, Tschīu-pì), da der i-Laut in beiden Silben völlig der gleiche ist.

Aber all dies sind, wie gesagt, Kleinigkeiten im Verhältnis zur Gesamtleistung. Wir beschliessen unsere Besprechung mit einem Dank an den Verfasser.

(Harvard University.) WILLY HARTNER.

Leslie J. Harris.—*Vitamins in Theory and Practice.* XIX+240. Cambridge: At The University Press; New York: The MACMILLAN Co., 1935 ($ 3.00).

This delightful book by the Director of the Nutritional Laboratory at Cambridge University, Dr. LESLIE HARRIS, originally formed the subject-matter of a series of four "Thursday afternoon" lectures at the Royal Institution, London, in 1934. The colloquial style of the lectures is retained in the book. The text is preceded by a clever poem "The A B C of the Vitamins," signed "C. H. A.," a poem which may be recommended to the attention of those who find it difficult to remember what their elementary vitamins are. In his first chapter entitled "The Discovery of the Vitamins" the author gives an extremely clear historical account of the recognition of the vitamin diseases and of the discovery of their causes. The story has often been told, and in perhaps no place more thoroughly and authoritatively than in the Special Report (No. 167) of The Medical Research Council published by His Majesty's Stationery Office at London in 1932. Dr. HARRIS' telling of the story is perhaps

an improvement upon that account to the extent that the philosophical aspects of the development of vitamin science are more particularly emphasized. It is a pleasure to see CASIMIR FUNK, the originator of the " vitamine " theory (1912) given his proper due. FUNK, as is well known, advanced the theory that there were four different " vitamines," one for beri-beri, one for scurvy, one for pellagra, " and probably also an anti-rickets vitamine." HARRIS points out that what led FUNK to this theory was not any new discoveries of his own, though his work on beri-beri is classical, but rather an intimate acquaintance with, and an intelligent study of, the relevant literature. " It seems " writes HARRIS " legitimate to point a moral. The intrepreter may be as useful to science as the discoverer. I refer here to any man who is able to take a broad view of what has already been done by others, to collect the evidence and discern through it all some common connecting link. At the present day there is a tendency for the young scientist to think that any small piece of ' practical ' work which he can do in a laboratory, justifying the publication of a paper, is necessarily of greater value than any amount of ' armchair science '—at which he is inclined to sneer." Such morals cannot be too frequently pointed out in this too " practical " age.

It is not proposed in this short review to recapitulate the epitomized story told by Dr. HARRIS. His book gives a complete and easily intelligible survey, devoid of technicalities, of the present state of our knowledge relating to the vitamins. It is sufficient to say that the book, which is well illustrated and contains many simple and useful tables may be read with profit and pleasure by all classes of readers. There is one question only. Dr. HARRIS attributes the phrase " the inevitability of gradualness " to Mr. RAMSAY MACDONALD (at whom he takes a sly dig); should it not rather more justly have been attributed to Mr. SIDNEY WEBB?

New York University. M. F. ASHLEY-MONTAGU.

T. K. Penniman.—*A Hundred Years of Anthropology.* 400 p. The MACMILLAN Co., New York, 1936, $4.50.

In the Preface to this book the author explains that it is intended primarily for the layman, the would-be Anthropologist, and for the specialist only to the extent to which the latter is a layman in those of the fields of which the book treats. As one who has passed through all three stages I can vouch for the interest which this book will have for these classes of readers . The book is, in its limited way, a good book, and makes informative and enjoyable reading, although as a " specialist " I found it to be not without its faults.

Actually the territory covered, and the treatment of the subject is

much the same as that of A. C. HADDON's excellent little book, namely, his *History of Anthropology*, published late in 1934 at one shilling by WATTS & Co. of London (*Isis* 25, 291). Mr. PENNIMAN's is the longer book, but I think he would agree that Dr. HADDON's is the better book. Mr. PENNIMAN's volume forms one in a series called A Hundred Years, in which it is proposed to include other volumes devoted to the last hundred years of progress in each of the sciences. It is to this venture on the part of the publishers that we owe the present volume.

In his opening chapter Mr. PENNIMAN gives a very satisfactory account of the scope of Anthropology as the Science of Man, and of the various branches of knowledge and their formal divisions which go to make up the subject, showing finally that " The Science of Man implies a synthesis of all the disciplines that throw light on him and his creations, " and that " to this synthetic study we give the name Anthropology." (p. 15).

Mr. PENNIMAN very properly points out that the " main part of the history of Anthropology occupies the last hundred years." These years, from 1835 to 1935, are divided up into three separate periods 1. The Convergent Period, from the thirties to the publication of *The Origin of Species* in 1859, during which the civilized world was gradually being prepared to recognize an integrated science of Man, 2. The Constructive Period, from 1859 to 1899, during which the greater part of the spade work in building up a recognized science of Anthropology was done, and 3. The Critical Period, from 1900 to the present day, so called for two reasons and in two senses, first, " because there is a general tendency to be critical about the large general schemes of the pioneers of the last century, and to examine special problems much more minutely than in the past," and second, because " it appears as though there was so much in every branch of Anthropology and in the many subsidiary sciences that it would be impossible for any one man to do more than to work intensively in one small part of the subject," hence the subject appears to be splitting up into a great number of independent disciplines, one independent worker becoming more or less of a stranger in the special field of another such worker.

The discussion of The Convergent Period is preceded by an interesting chapter entitled The Formulary Period, that is, the period from HERODOTOS (484-425 B.C.) to 1835, a period chiefly characterized by the relatively uncoördinated state of the existing knowledge relating to man.

In a final chapter the author discusses The Future Of Anthropology, and here indicates a few very limited lines of development.

In two appendices a chronological list of men and events in the history of Anthropology, and a useful list of some principal congresses,

anthropological museums, societies, and periodicals in various countries of the world are given. There is a good index.

So much for the scheme of a book which is destined to serve as a useful guide for many years to come in the tortuous though fascinating labyrinth of Anthropology.

Attention may be drawn here to some errors and omissions which should be rectified in a future edition of the book.

MOHAMMED IBN MUSA did not " invent " the zero, neither the concept nor the sign. p. 38.

De Humani Corporis Fabrica of VESALIUS was published in 1543 not 1542, and the story of his persecution by the Inquisition as given on p. 41 is at present purely apocryphal.

It is misleading to speak of " the precision of SPENCER's *Descriptive Sociology* " p. 46, for SPENCER's data were *selected*, exhaustively it is true, but nevertheless selected in order to prove a particular theory, hence, his " precision " is not of the kind that should even impliedly be recommended to-day.

It is hardly accurate to represent the doctrines of the Utilitarians as exponential of the doctrine of *laissez-faire*, pp. 62 & 137. Nor is it just to perpetuate the cruel and reprehensible myth that the philosophy of NIETZSCHE brings us back to the ethics of the jungle, p. 62.

The complete unreliability of the form of the shafts of hair in microscopic section as a criterion of any kind should have been indicated on p. 108 where the subject is referred to.

In the chapter on the Constructive Period, nor anywhere else in the book, is there any mention of CARL VOGT, one of the soundest and most brilliant Anthropologists of his day, whose book, translated into English as *Lectures on Man* by JAMES HUNT, and published by The Anthropological Society of London in 1864 is still one of the best books on the subject that we possess. Nor is there any mention of LOMBROSO and his school, of MANTEGAZZA and CANESTRINI, both of whom were, incidentally, DARWIN's correspondents and supplied him with a good deal of material which DARWIN used in *The Descent of Man*. The great *Dictionnaire des Sciences anthropologiques* published in Paris under the direction of the leading Anthropologists of the day during the years extending from 1886 to 1894 receives no mention either in the text or in the bibliography, nor, for that matter, does the recently completed *Encyclopaedia of The Social Sciences*. The fundamental and extremely important linguistic studies of BOAS and the school founded by him are passed over in silence, yet no " would-be Anthropologist " should be allowed to pass into the world without, at least, an acquaintance with the Introduction by BOAS to The Handbook of American Indian Languages

edited by him and published by the Bureau Of American Ethnology, Bulletin 40.

It is very amusing to find BOAS' observations on the changes in head-form of immigrants dismissed with the brief statement that they " have not generally been accepted," p. 285. Certainly they have been accepted by all who are capable of judging the evidence for themselves, and indeed, BOAS' observations are at this moment about to receive a most spectacular confirmation, which is not to say that they have not already upon previous occasions been confirmed by independent workers.

Finally, it is strange to find no mention of either growth, demographic or population studies, studies which at the present time are among the most promising of the numerous progeny of Anthropology.

New York University. M. F. ASHLEY-MONTAGU.

European Civilization. Its Origin and Development.—By Various Contributors, Under The Direction of EDWARD EYRE. Vol. I, Prehistoric Man And Earliest Known Societies. VI+844 pp. 19 Maps. New York: Oxford University Press, 1935, $8.75.

The present volume is the first of a series of seven which Mr. EDWARD EYRE, under whose direction they are being brought into being, tells us in his preface will exhibit " with the necessary fullness *(sic)* but without detailed narrative, the rise of Europe and the distinctive character of European civilization." The idea is an excellent one, and the quality of the contributions to this, the first volume, promises well for the whole work. If I cannot agree with any one of Pater WILHELM SCHMIDT's statements and notions in the opening contribution of 77 pages entitled ***Primitive Man, A brief critical examination of the subject and a systematic statement based on demonstrated facts***, that is perhaps due to the peculiar situation that Pater SCHMIDT's and my own notion of what a " demonstrated fact " is do not agree. Pater SCHMIDT, who has for many years been an extraordinarily prolific writer in the field of ethnology, is an orthodox Catholic and a Director of the Lateran Museum of Ethnology and the Missions... His religious beliefs apparently prevent his acceptance of what most scientists consider to be as nearly demonstrated fact as one may rightfully expect, namely, man's origin from an ape-like stock. Reading Pater SCHMIDT one feels oneself transported back to the holy days of Bishop WILBERFORCE. Pater SCHMIDT does not like what he calls our " enthusiasm for the monkeys," and he goes on to show us that the authorities are by no means agreed among themselves upon this vexed subject of man's ancestry. As his most telling authority SCHMIDT gives us the late HENRY FAIRFIELD OSBORN (to whose surname he repeatedly affixes a gratuitous ' e ') who, as is well known, in his

last years rejected the idea of man's ape ancestry, substituting instead man's origin from what he called a " dawn-man." The chicken, in short, is not derived from the egg but from the chick, for if man is not derived from an ape-like stock but from a " dawn-man " stock, from what stock was the " dawn-man " stock derived? OSBORN never seems to have been troubled by this question, and Pater SCHMIDT feels that " Our best attitude with regard to the question of the descent of man, so far as his bodily form is concerned, must be a patiently expectant one, with an evenly balanced mind, waiting till further discoveries and researches give us a decisive result as has already been attained with regard to the question of the descent of the soul of man from some earlier existing forms of life. This latter question has already been settled in the negative with complete certainty " (p. 81). The view of the very learned Bishop of Birmingham, Dr. BARNES, that " a general acceptance of the Darwinian hypothesis demands an entire reconstruction of theology, and an abandonment, or at least revision, of fundamental doctrines, which have been regarded as truths for more than nineteen hundred years," causes Pater SCHMIDT to express surprise that " his Lordship is prepared to replace truths of such venerable antiquity by myths that came into fashion about a century ago." Here, too, Pater SCHMIDT's notion and my own as to what a myth is do not agree. Pater SCHMIDT's discussion of the morphological facts relating to man's ancestry is throughout that of the strongly biassed objector, nevertheless he makes very stimulating reading.

Pater SCHMIDT's discussion of religion and morality is likewise stimulating because it is so excessively one-sided. For example, Pater SCHMIDT believes that the belief in a Supreme Being, in a Creator, is universally distributed among the peoples of the world, and that this Supreme Being is invariably considered to be morally good. On this subject Pater SCHMIDT has for the last thirty years been our greatest authority. Yet I venture to disagree with him. It is impossible here to go into details, and I must here content myself by briefly stating the facts about one people, the Arunta of central Australia. These people believe in an eponymous ancestor, a sort of being who came out of nothing, as the natives say, Numbakulla, who brought them all into being; the Arunta do not regard this ancestor as a Supreme Being, they do not worship him, and what is most important, they do not invest him with any moral attributes whatever. Actually, they believe that after Numbakulla had performed his labours, i.e., in causing the Arunta world to be peopled, he disappeared altogether. Such facts cannot be reconciled with Pater SCHMIDT's views, unless, of course, they are forced to fit into his Christian view of these matters. But Pater SCHMIDT's

contribution must be read, for its value lies in its great power of producing fruitful disagreements.

There are an unnecessarily great number of errors in the spelling of proper names.

The succeeding contributions to this volume are unexceptionally exemplary. There are two comprehensive essays from the pen of Professor J. L. MYRES, the first entitled *The ethnology and primitive culture of the Nearer East and the Mediterranean world*, and the second, which supplements the first, *The ethnology, habitat, linguistic, and common culture of Indo-Europeans up to the time of the migrations*. These essays could hardly have been better done, and only one thing is to be regretted in connection with them, and that is the absence of a select bibliography which would have much increased their value. In the next essay Professor C. F. JEAN gives us an exceptionally clear account of *The East* from protohistoric times to the period of Hellenization. There is a good short bibliography. The late T. E. PEET (1882-1934) then deals with *Ancient Egypt* from Predynastic times to the Persian period. There is a short bibliography. In what is virtually a book in itself (274 pp.) A. W. GOMME treats of *The Greeks* from the Bronze Age to the end of the Classical period following the Macedonian conquest. There is, unfortunately, no bibliography. In a final essay, *Additional Notes* on the East, Professor JEAN devotes himself to giving an account of Phoenicia from the 20th to the 13th century B.C. In a second part of the same essay India and Sumeria in the third millennium B.C. are dealt with in the light of recent excavations. This essay provides a valuable summary of the archaeological findings up to July 1933. References are supplied in the footnotes. The volume is completed by an excellent index.

New York University. M. F. ASHLEY-MONTAGU.

A. S. Diamond.—*Primitive Law.* x+451 pp. LONGMANS GREEN & CO. London, 1935, 25/-.

I had looked forward to reading this book with some pleasure, for a work on primitive law has for long been a most urgent desideratum, a glance, however, at the description of the book printed upon its dust-jacket made it clear that if what was there promised were realised in the text such a work would now more than ever be urgently desirable. And so it has proven.

Mr. DIAMOND is a lawyer with a more than ordinary interest and equipment in law who has realised that MAINE's belief in the religious origin of law (Cf. *Ancient Law*, 1861) will not, in the light of modern knowledge, bear examination. That MAINE's views are still very much

alive today, in legal circles at least, is not to be wondered at, since wherever law is taught his *Ancient Law* is very rightly made part of the student's required reading. Mr. DIAMOND has therefore performed a very useful service in drawing attention to one of the major defects of the book. In a very delightful book entitled *Civilization and the growth of law* (MACMILLAN, 1935) by Dr. WILLIAM A. ROBSON which I read some months ago the author arrived at the conclusion that " law in early society is generally believed to have come directly from God," and, on the whole, Dr. ROBSON tends to support MAINE's view of the early origin of law. MAINE, it will thus be seen, still has his supporters. Mr. DIAMOND seems to have been unaware of Dr. ROBSON's book; this is a pity for more reasons than one, for among other things Mr. DIAMOND might have learnt from it the existence of a number of sources of material which as it is he has left untapped. Dr. ROBSON is not altogether faultless in respect of his apparatus of authorities, but he has done as well as any one has a right to expect; Mr. DIAMOND, however, has failed to acquaint himself with the most obvious authorities in the field of primitive law, and in consequence he is from the very outset handicapped by a lack of knowledge which has proven fatal to his book. Apart from having overlooked such very recent (1934) fundamental contributions to the subject of primitive law as RADCLIFFE-BROWN's article in *The encyclopaedia of the social sciences*, and MALINOWSKI's introduction to, as well as the text of IAN HOGBIN's *Law and order in Polynesia*, Mr. DIAMOND has overlooked by far the largest proportion of the source books dealing with primitive law. He does not even mention such an obvious book as HARTLAND's *Primitive Law* (London, 1926). But for Mr. DIAMOND's purpose few authorities are necessary. Convinced that with a certain stage of economic development there is always more or less associated a definite stage of legal development, Mr. DIAMOND gives us a brief description of certain aspects of the laws of a few lower and higher hunting peoples, and also of a few agricultural and pastoral peoples, restricted chiefly to Africa and to Australia. On the basis of these descriptions he traces what he imagines to be the evolutionary stages in the development of law. Had he been writing at the beginning of this century, Mr. DIAMOND's methodology might have been deprecated, but in our present year of grace we can only wonder where Mr. DIAMOND has been keeping himself, for he appears never to have been exposed to the notion that the *principle* of evolution is not a *method*, that there is no such thing as an " evolutionary method," and that the method which led to the discovery of this principle is the *historical method*, as the discoverer of the principle, CHARLES DARWIN, himself so perfectly demonstrated. Wherever Mr. DIAMOND may have been during the

last thirty years, certainly he has escaped all appearance of contact with such notions for he is quite content to follow the old method of selecting whatever he wants from each people and in this way to build up a unilinear picture of the development of law. The original cause of Mr. DIAMOND's trouble appears to have been his acquaintance with HOBHOUSE, WHEELER, and GINSBERG's excellent study *The material culture and social institutions of the simpler peoples. An essay in correlation*, from which *statistical* study Mr. DIAMOND seems to have gained the impression that with certain " stages of economic culture,"—to quote the first chapter heading of the latter study,—certain cultural traits were invariably associated. Had he read the book carefully he would have discovered how incorrect such an idea could be. Had Mr. DIAMOND restricted himself to the study of the functioning of law and legal processes in a single primitive community and presented us with the *facts* instead of the eclectic generalizations which he has given us, his contribution might have been a very real one. HUXLEY once said that SPENCER's idea of a tragedy was a generalization killed by a fact. Mr. DIAMOND, it is to be hoped, is not in similar case, for almost all his generalizations must fall ready victims to the facts. It cannot be too often pointed out that every social group is a law unto itself, and in order to be properly understood must be studied as a self-related and integrated whole, apart from all other considerations. To group societies according to their modes of life arbitrarily into lower and higher hunters, and so on, and in so doing be led to the belief that one may then legitimately compare all groups of lower hunters with one another as total social wholes or in respect of any particular trait, as, for example, against higher hunters, is perfect nonsense, as may be immediately shown by comparing any two such groups as, for instance, the Bushman and the Australian; both are lower hunters; that is to say that upon the purely economic plane there is a certain broad resemblance between them, but that is where the resemblance begins and ends, for *culturally* these two social groups differ very widely from one another; their cultures are *different*, and in so far as they are different in respect of their categories of thought, their language, their hunting implements, their social organization, their mythology and their religion, in so far will they differ in respect of the nature of their processes of law. What may be present in the one may not be present in the other, and in general may be relied upon not to be so present. Let me briefly illustrate this by comparing two lower hunting peoples, the Australians and the Andaman Islanders, in connection with their governmental processes. Among the first people we find an elaborately developed governmental structure, with a council of wise men who settle all important tribal business, and adjudicate in brawls,

in matters of incest, revenge parties, and sorcery. Among the Andaman Islanders there does not exist anything of this kind at all. For agricultural peoples the story is the same. In Africa, for example, we find trial by judge and jury, payments, and fines, and the codification of law in proverbs. In America, among the agricultural Zuni, for instance, there is no governmental body before whom disputes may be brought for settlement, all disputes must be settled in conversation. Here, indeed, are extreme differences between peoples on an economically equivalent level of development. Such examples could be greatly multiplied, but all this is extremely elementary, and had Mr. DIAMOND taken the trouble to look into the numerous anthropological sources available to him he might have made this simple but fundamental discovery for himself. From these sources Mr. DIAMOND would also have learnt that every people of whatever level of development makes a clear distinction between the secular and the religious, and in such sources he would have found much material in support of his thesis that law is secular in origin rather than religious.

I have already said sufficient, I hope, to indicate that this book is not a good book, for the approach of the author to his subject is methodologically unsound, and his conclusions as a result are fallacious. Perhaps Mr. DIAMOND may be persuaded to try again.

With all its faults, however, Mr. DIAMOND's book has some excellent points, his accounts, for example, of the laws of the Babylonians, Sumerians, Assyrians, Hittites, and Hebrews, are extremely good. His analysis of the Hebrew Code (*Exod.* XXI, 2,-XXII, 17), is a valuable contribution to our understanding of what is originally secular in it and what the result of priestly addition. This part of the book may be heartily recommended, but, alas, not that part of it which claims to deal with the law of primitive peoples.

New York University. M. F. ASHLEY-MONTAGU.

Olive M. Griffiths.—***Religion and learning.*** A study in English Presbyterian thought from 1662 to the foundation of the Unitarian movement. 202+VIII pp. Cambridge University Press, 1935. (12/6).

Miss GRIFFITHS adds a noteworthy chapter to the rapidly growing literature on the relations between Protestantism and modern intellectual development. The particular merit of this work lies in its systematic exploitation of materials pertaining to Nonconformist, and more especially to Presbyterian, thought, which have hitherto been largely neglected. Of these sources, the manuscript lecture notes of students at Nonconformist academies are especially useful since they demonstrate clearly

the stress laid upon the new philosophy by these academies in sharp contrast to the curricula of the universities.

The author maintains that the general trend of Presbyterian thought, from the early seventeenth to the close of the eighteenth century, was a consequence of the contemporary developments in science, philosophy, epistemology and psychology. Secular learning evidenced such rapid advances that the Presbyterians were obliged to examine their own basic tenets, that is, to " accommodate " their ideas to developments in other compartments of thought.

Miss GRIFFITHS points out further that the Presbyterians were not debarred by poverty or by paucity of opportunity from participating in the intellectual movements of the day. In contrast to their initial conservatism and orthodoxy, they later manifested a marked predilection for the new science, avowed the value of reason and experiment, and vigorously criticized authoritarianism generally, and in thought specifically. Moreover, since subscription to the 36th Canon was demanded of all suppliants for degrees in both the English universities, the Presbyterians turned to the universities of Leyden, Utrecht, Edinburgh and Glasgow. It is to the instructive and liberalizing contact with systems of thought current in Holland that Miss GRIFFITHS attributes largely, though perhaps gratuitously, the Presbyterian espousal of the right of private interpretation of the Scriptures—which of course involved an implicit rejection of authoritarianism—and of rationalism generally.

Miss GRIFFITHS properly distinguishes the social and intellectual ideas of the early Presbyterians from their later conceptions. However, it does not follow, as the author explicitly maintains, that these later favorable attitudes of Presbyterians toward the new science, logical consistency, utilitarianism, and revolt against sheer authority were simply an accommodation of religious thought to new developments in the various scientific and intellectual disciplines. That is to say, the author unwarrantably assumes that the initial religious conceptions are static and fixed and that changes in these ideas must be attributed to factors " external " to the religious system of thought. In fact, there is a considerable body of evidence—in the writings of MAX WEBER, TROELTSCH, R. F. JONES, MERTON and others—tending to show that these developments may have been simply a *psychological (not logical)* consequence of the implications of the Calvinist ethic. The readiness of Presbyterians, and of Calvinist sects generally, in contrast to the orthodox Anglicans, to turn to the new science would seem to indicate an initial predisposition, based on the values implicit in their ethic, favorable to the new natural philosophy. If this were simply a case of religious accommodation,

how can one explain the facts that the Calvinist sects more readily cultivated the new scientific pursuits? The materials pertaining to the Reformist academies assembled by Miss GRIFFITHS herself (as well as by IRENE PARKER), Dean STIMSON's studies which found an unusual concentration of Puritans in the Royal Society during its formative stages and kindred associations on the Continent all constitute stumbling-blocks to the acceptance of the author's basic general contention.

This assumption of Miss GRIFFITHS has been subjected to a rather lengthy discussion since it is basic to her entire interpretation of the materials. It is equally necessary to state, however, that her exposition of the actual changes in Presbyterian thought is extremely useful. The concise account of the adoption by Presbyterians toward the end of the seventeenth century of Arminianism, predicating the " dignity of man and the value of his works," and of the changes in the following century from Calvinism to Unitarianism may well be singled out for especially favorable notice. The similarity of the values embodied in scientific disinterestedness and in eighteenth-century Unitarian thought may be succinctly summarized by the following excerpt from the charge of Dr. JOHN TAYLOR to his students at Warrington Academy. " That if at any time hereafter any principle or sentiment by me taught or advanced or by you admitted and embraced, shall upon impartial and faithful examination appear to you to be dubious or false, you either suspect or totally reject such principle or sentiment. That you keep your mind always open to evidence; that you labour to banish from your breast all prejudice, prepossession, party zeal..." If this be a representative attitude, small wonder that the Nonconformist academies could produce a PRIESTLEY.

A brief classified bibliography adds to the usefulness of this little book.

Harvard University. ROBERT K. MERTON.

Rafael Karsten.—*The Origins of Religion.* VII+328 p. London, KEGAN PAUL, 1935 (12/6).

Professor KARSTEN may always be relied upon to be both instructive and stimulating. Those who are acquainted with his earlier works, chief among which is his admirable *Civilization of the South American Indians* (1926), know that he spent some five or six years among certain of the native tribes of South America, and that he is therefore no mere " desk-anthropologist,"—not that desk-anthropologists may not be better anthropologists than many field workers have been, witness the brilliant contributions to anthropological theory of such students as TYLOR, FRAZER, WESTERMARCK, ANDREW LANG, GRAEBNER, and LÉVY-BRUHL, but it is a fact that desk-anthropologists are, on occasion, apt to be *merely*

desk-anthropologists without any real insight into the mentation of simpler peoples, such as the intelligent field worker is bound to acquire, an insight which among our present-day desk-anthropologists has been conspicuously successfully arrived at by the much-misunderstood and misinterpreted Professor of Philosophy at the Sorbonne, LUCIEN LÉVY-BRUHL. It is, of course, in keeping with the general misunderstanding of LÉVY-BRUHL's writings that Professor KARSTEN should also share that misunderstanding.

In the present work Professor KARSTEN offers us a reconsideration of the whole theory of primitive religion as it has been developed up to the present day. He brings to bear a great deal of new material upon the problems considered from the region of South America and the virtually unknown Finno-Ugrian area where Finnish and Russian ethnologists have recently been working, and thus at once puts us into his debt.

Following an introductory chapter in which the necessity is emphasized for the restriction of our present activities in the study of religion to the intensive and detailed field study of particular peoples and particular areas before we proceed to write our general comparative works, Professor KARSTEN proceeds to discuss the existing modern theories of religion. He is careful to point out that the first beginning of the belief in the supernatural world we shall never be able to trace with absolute certainty, and that in dealing with this problem at all we merely use hypotheses of greater or less probability. The various early hypotheses, those of ROBERTSON SMITH, E. B. JEVONS, ANDREW LANG, and Pater SCHMIDT (who is still putting out the most prodigious works), which each postulate a process of degeneration from a higher to a lower form of religion and superstition, are examined and found wanting. SPENCER's hypothesis that religion originated in the worship of the souls of the departed, Professor KARSTEN considers to be less objectionable; what, he points out, is unsatisfactory in SPENCER's work is not so much his general theory as the arguments he brings to its support, his deductive procedure; apart from his doubtful arguments his general theory finds a great deal to support it in the present-day beliefs of the simpler peoples. TYLOR's theory of animism, the belief in the ubiquity of spiritual beings (*Primitive Culture*, 1871), originating in dreams and similar phenomena, the author considers to be still the most satisfactory theory of the primitive essence of religion, and by no means superseded by the alleged pre-animistic stage supposed to be characterized by a belief in impersonal magical powers, *mana*, (CODRINGTON, 1891; MARETT, 1909).

In the succeeding chapter before entering upon an examination of the pre-animistic theory, the author discusses the problem of the psycho-

logy of primitive man. LÉVY-BRUHL is severely criticized for terming the thinking of primitive man *pre-logical* as distinguished from the logical thinking of more highly civilized man. The usual arguments make their appearance : that there is every reason to believe that the primitive reasons as logically as we ourselves do, that in so far as the primitive is *pre-logical* so are we, *und so weiter*. The fact, however, is that the primitive does, as far as his religious thought is concerned, order his beliefs by purely *pre-logical* processes of thought. His thought may be described as having its roots in affective-imaginative experiences, experiences which from the first have played only upon his emotions and imagination, almost before any of his rational processes came to be established. Born into a world peopled with spirits, in which almost everything is surcharged with spiritual significances, he comes by a mystic participation in the behaviour of those who make these things known to him, in their " collective representations " as LÉVY-BRUHL terms them, to acquire a type of mind and a way of thinking which is non- or pre-rational and non- or pre-logical, but purely affective and imaginative in quality and operation. This is so in the context of the religious, in the context of the secular the primitive is as rational and as logical as anyone. This, fundamentally, is LÉVY-BRUHL's view, and no one, including Professor KARSTEN, has ever been able to shew wherein it was invalid. The primitive religionist is neither a logician nor a rationalist, any more than his more highly civilized compeer is, but as a secular being he is logical and rational enough. The point is not that we are often as pre-logical as the primitive is, but that the primitive is pre-logical most of the time because of the greater extension of his religious existence which produces the type of thinking which he gives to it, whereas we amongst whom religion has ceased to play a significant rôle and from the tyranny of which most of us have been released have but little occasion to be pre-logical in our thinking. Professor KARSTEN believes that the animistic beliefs, the religions of primitive peoples " are built up in an admirably logical way."

It seems to us that Professor KARSTEN has here fallen into the usual error; he sees a religious " system " which is in every particular extremely well constructed and which works beautifully. Explanations are given by the natives of the various rites and cults associated with the religious ceremonies, and reasons are given for the traditional beliefs of great ingenuity, hence, concludes the inquiring student, this is all a most remarkable feat of the intellect, an amazingly devised spiritual-naturalistic system, an extraordinarily valid account of the world in which the native conceives himself to live. Clearly it was all put together by processes

of logical reasoning and speculation. How admirable and how intellectually impressive! But nothing could be further from the truth; this is a matter, however, which cannot be proven here. It would not be true to say that religious beliefs have never been arrived at by any processes of the mind other than those which are determined by its affective and its imaginative aspects, reason as such has played a rôle, but that rôle (we are speaking of primitive religion) has been considerably less significant in the development of early religion than the rôle played by the emotions and the imagination. That Professor KARSTEN is quite aware of this is strangely clear, for after emphasizing the rôle of the imagination in the development of religious ideas he goes on to say that "It is the sentiment that is the primary trait of religion. The ideas form rather a secondary element of it. From this point of view we may find unsatisfactory TYLOR's definition of religion as being simply a belief in spiritual beings. It lays too much emphasis upon the intellectual side of religion disregarding the emotional side" (27). Precisely LÉVY-BRUHL's point. It will no doubt surprise Professor KARSTEN to learn that he really belongs in the school of LÉVY-BRUHL, but what he has here written inseparably identifies him with that school.

Professor KARSTEN shows how it has happened that in starting from the phychological facts of primitive mentation traces of a still earlier stage of religious thought than the belief in spirits have been sought for, namely, a pre-animistic stage. The concept of *mana* (CODRINGTON, 1891) as developed by MARETT in his *The Threshold of Religion*, (1909), is, as is well known, to-day the most generally accepted description of this stage of religious development (*cf.* also K. T. PREUSS). *Mana* has been taken to represent the impersonal power which is conceived to be resident in certain things and people, a transferable quality, something in the nature of an electrical charge, possessing the character neither of a soul, spirit, nor being, and being totally independent of spiritual connections. This conception of *mana* Professor KARSTEN very ably attempts to shew is altogether and completely erroneous, as also is the concept which is supposed to define the realm of *mana*, namely, *animatism*. With rare cogency Professor KARSTEN points out that there is nothing whatsoever in CODRINGTON's writings which would lend the slightest support to the prevailing non-animistic conception of *mana*, that on the other hand CODRINGTON insisted on its animistic nature, as, for example, he does in the following passage which Professor KARSTEN has apparently failed to note and which he might have quoted to great effect; CODRINGTON writes "This mana is not fixed in anything and can be conveyed in almost anything; but spirits, whether disembodied souls or supernatural beings, have it and can impart it;

and it essentially belongs to personal beings to originate it, though it may act through the medium of water, a stone, or a bone." (*The Melanesians*, Oxford, 1891, pp. 118 sqq.). The italicized words are self-explanatory. Professor KARSTEN claims that in every case it can be demonstrated that the so-called impersonal power alleged to be represented by *mana* is always immediately derived from some quite definite spiritual source, and that it is therefore quite wrong to endow this spiritual power with an independent existence *sui generis* and a priority in the evolution of religion to the belief in personalized spirits such as the pre-animists have assigned to it. Professor KARSTEN will be interested to learn that Dr. IAN HOGBIN has independently arrived at a precisely similar viewpoint in a study which has just appeared in *Oceania*, IV:3, March 1936, pp. 241-274, entitled *Mana*. In Professor KARSTEN's view the pre-animists have arbitrarily separated the power deriving from the spiritual source and given it a special existence, an act which he considers the evidence to render quite unallowable. He therefore suggests that the *mana* theory, the theory of animatism, is an erroneous fiction which ought to be removed from the field of primitive religion, a view with which the reviewer is in complete agreement. The greater part of Professor KARSTEN's book is devoted to the examination of the relevant evidence which has been collected from among various primitive peoples, the eivdence cited invariably shewing the fundamental animistic nature of the religious beliefs and practices of these peoples. This evidence is cited in great detail. Unfortunately, a final chapter summarizing and discussing the significance of all this evidence is wanting, so that when the last word has been read one finds oneself unexpectedly left to one's own reflections. Actually the thesis of the book is set out in the first part of the book and the evidence in its support is given in the second and more extensive part, so that it is necessary to return to the first part upon concluding the second to refresh oneself somewhat upon the precise nature of the thesis that Professor KARSTEN has been seeking to maintain. And when this has been done it is impossible to resist the conclusion that Professor KARSTEN has been successful in making out his case.

Professor KARSTEN's book represents an important and valuable contribution to the study of primitive religion and it is certain to have a considerable influence in bringing about a reexamination and a revaluation of some of the concepts, the fundamental concepts, which at present litter the field of comparative religious studies.

New York University. M. F. ASHLEY-MONTAGU.

Forty-seventh Critical Bibliography

of the

History and Philosophy of Science and of the History of Civilization

(*to end of April* 1936,—*with special reference to Israel*)

This forty-seventh Bibliography contains about 325 items of which 84 deal with Israel. They have been kindly contributed by the six following scholars :

C. A. KOFOID (Berkeley, Cal.)
C. D. LEAKE (San Francisco)
J. PELSENEER (Brussels)
A. POGO (Washington, D.C.)
G. SARTON (Cambridge, Mass.)
H. R. VIETS (Boston).

This Bibliography includes as usual a series of addenda and errata to SARTON's *Introduction to the History of Science*, vols. 1 and 2 (Baltimore and London, 1927 and 1931). Its purpose and methods have been explained in the preface to the thirty-eighth Critical Bibliography (*Isis* 20, 506-08).

The section on Israel is especially full, as I have liquidated as much as I could of my stock of notes concerning it.

I have in my drawers a large number of notes which I will be glad to publish as soon as I have been able to check them upon the originals.

I entreat the authors of relevant books and papers to send me copies of them *as promptly as possible* in order that their studies may be registered in this bibliography and eventually reviewed and discussed. By so doing they will not simply help me and every other historian of science but they will help themselves in the best manner for they will obtain for their work the most valuable publicity and its certain incorporation into the literature of the subject.

Many of the notes were checked and the final manuscript and proofs of this Critical Bibliography were kindly read by Dr. M. C. WELBORN.

Harvard Library 185 GEORGE SARTON.
Cambridge, Mass.
May 1, 1936.

PART I

FUNDAMENTAL CLASSIFICATION (CENTURIAL)

VIth Century B.C.

Hattori, U. CONFUCIUS' conviction of his heavenly mission. *Harvard journal of Asiatic studies* 1, 96-108, 1936. ISIS

Vth Century B.C.

Luria, S. Die Mechanik DEMOKRITS. *Archives of the history of science and technology* 7, 129-80, Leningrad, 1935 (in Russian with German summary). ISIS

"Der Verfasser sucht zu beweisen, dass die vorherrschende Auffassung nach welcher die vorarchimedische Mechanik mit der des ARISTOTELES so gut wie identisch zu halten sei, durchaus falsch ist. Trotz der Dürftigkeit der Bruchstücke der atomistischen Mechanik, darf man glauben, dass diese Mechanik der archimedischen und der modernen Mechanik viel näher stand als die aristotelische, die ein bewusster reaktionärer Rückschritt gegen die atomistische Mechanik war. Als Grundsatz der demokritischen Mechanik diente ein Satz, den wir wohl als eigenartiges *Prinzip des hinreichenden Grundes oder als statistisches Symmetriegesetz zu bezeichnen haben.*" ... "Es folgen fünf Exkurse: 1) über das Oben und das Unten in der 'grossen Leere' (DEMOKRIT waren diese Vorstellungen ganz fremd); 2) über STRATON und seine Polemik gegen die Lehre DEMOKRITS; 3) über die Lehre von der gegenseitigen Wirkung der gleich- und ungleichartigen Körper beiden griechischen Philosophen; 4) über einige Schwierigkeiten, die die Lehre von der gegenseitigen Anziehung der gleichartigen Partikeln nach sich zieht; 5) über die Ursachen der Unbeweglichkeit der Erde."

Melikova-Tolstaja, S. Eine Theorie des Sehens bei GORGIAS. *Archives of the history of science and technology* 7, 367-74, Leningrad, 1935. ISIS

"GORGIAS' Satz in der 'Lobrede auf Helena' § 17 gibt eine wissenschaftliche Erklärung des Sehvorganges wieder."

Moberg, Axel. HERODOTOS and modern reconstructions of the tower of Babel. *Le monde oriental* 25, 140-64, 10 fig., 1931. ISIS

IVth Century B.C. (second half)

Aristotle's Physics. A revised text with introduction and commentary by WILLIAM DAVID ROSS. Oxford University Press, 1936 ($12.00). ISIS

The contents of the volume are : Books referred to; Introduction; I. The structure of the *Physics*, II. ARISTOTLE's natural philosophy, III. The text of the *Physics*. *Physics:* text, sigla, second version of vii 1-3, Analysis, commentary; Indexes; Index verborum, Index to the introduction and commentary.

Einarson, Benedict. On certain mathematical terms in ARISTOTLE's logic. *American journal of philology* 57, 33-54, 151-72, 1936. ISIS

IIIrd Century B.C. (whole and first half)

Baudoux, Mlle. Claire. La version syriaque des " Eléments " d'EUCLIDE. Comptes rendus, IIe Congrès national des sciences, Bruxelles, 73-75, 1935. ISIS

Kugener, M. A. Les versions latines des " Eléments " d'EUCLIDE conservées à la Bibliothèque publique de Bruges. Comptes rendus, IIe Congrès national des sciences, Bruxelles, 70-72, 1935. ISIS

IInd Century B.C. (second half)

Morgan, Evan. Tao, the great luminant, essays from Huai-nan-tzŭ. With introductory articles, notes, analyses. Shanghai, KELLY & WALSH, 1934. ISIS

Reviewed by R. F. J., *Bulletin of the school of oriental studies* 7, 923-27, 1935. " This book contains translations of eight of the twenty-one dissertations that make up the famous book known as *Huai-nan-tzŭ*, a collection of Taoist essays written by a group of scholars in the second century B.C. under the patronage of LIU AN, Prince of Huai-nan (d. 122)."

Ist Century B.C. (whole and first half)

Pogo, Alexander. The date of the 2000th anniversary of the birth of HORACE. *Popular Astronomy* 44, 134-35, 1 fig., 1936. ISIS

" The choice of A.D. 1935 December 8 (Gregorian) as the date commemorating the Horatian bimillennium is objectionable on two grounds : first, the year is wrong, due to the common but erroneous assumption that M + N years separate a given date of the Mth year of the Christian era

from the same date of the Nth year B.C.; second, the day of the month is wrong, on account of the confusion of Julian and of Gregorian anniversaries." "A.D. 1936 December 8 Julian (1936 December 21 Gregorian) marks the lapse of 2000 Julian years since December 8, 65 B.C." "A.D. 1936 December 6 Gregorian marks the lapse of 2000 Gregorian years since December 6 Gregorian, 65 B.C., *i.e.* the 2000th return of the sun to the longitude 254°."

Ist Century (second half)

Edelstein, Ludwig. WINCKELMANN and the translation of DIOSCURIDES. *Bulletin of the institute of the history of medicine* 4, 261-63, 1936. ISIS

"The first German translation of DIOSCURIDES appeared in 1546, while the second was not published until 1902. However, in the long period between those two dates another German version was at least planned. It was J. J. WINCKELMANN (1717-1768), the founder of classical archeology, who was charged with this task by G. L. BIANCONI with whom he had become acquainted in Dresden."

IVth Century (second half)

Rome, A. Note sur le commentaire de l'*Almageste* par THÉON D'ALEXANDRIE. Comptes rendus, IIe Congrès national des sciences, Bruxelles, 68-9, 1935. ISIS

Vth Century (whole and first half)

Bidez, Joseph. Le texte du prologue de SOZOMÈNE et de ses chapitres (VI 28-34) sur les moines d'Egypte et de Palestine. *Sitzungsberichte der Preussischen Akademie der Wissenschaften*, phil.-hist. Klasse, 18, 31 p. Berlin, 1935. ISIS

IXth Century (whole and first half)

Bouyges, Maurice (S. J.). 'ALIY IBN RABBAN AL-ṬABARIY. *Der Islam* 22, 120-21, 1935. ISIS

Apropos of a Constantinople MS. of a work of his written in answer to Christians. G. S.

Jones, Charles W. A note on concepts of the inferior planets in the early Middle Ages. *Isis* 24, 397-99, facs., 1936. ISIS

Apropos of two MS. of BEDE's scientific works, both of the middle of the ninth century, the one at Melk, Austria (Cod. mellicensis 370), the other at Karlsruhe (Reichenau 167), a diagram from which is reproduced. G. S.

Xth Century (whole and first half)

Ruska, Julius. Studien zu MUḤAMMAD IBN UMAIL AL-TAMĪMĪ's Kitāb al-Mā' al-Waraqī wa'l-Arḍ an-Najmīyah. *Isis* 24, 310-42, 2 facs., 1936. ISIS

Apropos of H. E. STAPLETON: Three Arabic treatises on alchemy by MUḤAMMAD IBN UMAIL (Calcutta, 1933; *Isis* 22, 331). This has revealed the Arabic text which is the source of the *Epistola Solis ad Lunam crescentem* and shown how much that text had suffered in its transmission. RUSKA's elaborate study is divided as follows: 1. Die Vorfabel und ihre bildliche Darstellung; 2. Die Überlieferung des lateinischen Textes; 3. Der Aufbau des Lehrgedichts; 4. Der Charakter des Kommentars; 5. Die von IBN UMAIL benützten Quellen; 6. Allegorische und praktische Alchemie. G. S.

XIth Century (whole and first half)

Abel, Armand. La sélénographie d'IBN AL HAITHAM (965-1039) dans ses rapports avec la science grecque. Comptes rendus, II[e] Congrès national des sciences, Bruxelles, 76-81, 1935. ISIS

Obermann, Julian. Studies in Islam and Judaism: the Arabic original of IBN SHĀHĪN's *Book of comfort* known as the *Ḥibbūr yaphē* of R. NISSIM B. YA'AQOBH, edited from the unique manuscript. (*Yale oriental series, researches* 17). New Haven, Yale University Press, 1933. ISIS

Apropos of NISSIM BEN JACOB BEN NISSIM BEN SHAHIN, who flourished in Qairawān, c. 1030-40. See STEINSCHNEIDER: *Die arabische Literatur der Juden* (1902, p. 103.) G. S.

Wiet, Gaston. FIRDOUSI. *Journal asiatique* 227, 101-22, 1935 (received March 1936). ISIS

XIth Century (second half)

Herrmann, Albert. Die älteste türkische Weltkarte (1076-n. Chr.). *Imago mundi* 1, 21-28, 1935. ISIS

XIIth Century (second half)

Cahen, Claude. Quelques mots à propos d'un médecin d'AMAURY et de SALADIN. *Syria* 15, 351-60, 1934. ISIS

Apropos of USĀMAH IBN MUNQIDH (XII-2) for whom see my *Introd.* 2, 446. G. S.

Corbin, H.; Kraus, P. SUHRAWARDĪ D'ALEP. Le bruissement de l'aile de GABRIEL, traité philosophique et mystique, publié et traduit avec une introduction et des notes. *Journal asiatique* 227, 1-82, 1935 (received March 1936). ISIS

Edition and translation of the *Risālat āwāzir Jabri'īl* by YAḤYĀ IBN ḤABASH IBN AMĪRAK AL-SUHRAWARDĪ (XII-2), *Introd.*, 2, 361. G. S.

Feldman, W. M. The life and medical work of MAIMONIDES. *Proceedings of the Royal society of medicine, section of the history of medicine* 28, 23-6, London, 1934-35. ISIS

Hocking, William Ernest. CHU HSI's theory of knowledge. *Harvard journal of Asiatic studies* 1, 109-27, 1936. ISIS

Tuulio, O. J. Le géographe arabe IDRĪSĪ et la toponymie baltique de l'Allemagne. *Annales Academiae scientiarum Fennicae* B30, 259-72, 1934. ISIS

Tuulio, O. J. Du nouveau sur IDRĪSĪ, sections VII, 3, VII 4, VII 5 : Europe septentrionale et circumbaltique, Europe orientale et, d'après quelques manuscrits, centrale jusqu'à la péninsule balkanique au Sud. Edition critique, traduction, études. x+242 p., 17 fig. (Studia orientalia edidit societas orientalis fennica, VI, 3). Helsingfors, Société de littérature finnoise, 1936. ISIS

Wolfson, Harry Austryn. Note on MAIMONIDES' classification of the sciences. *Jewish quarterly review* 26, 369-77, 1936. ISIS

XIIIth Century (second half)

Boffito, Giuseppe; Melzi d'Eril, C. Il trattato dell'astrolabio di PIETRO PEREGRINO DI MARICOURT. Introduzione e saggio del codice Vaticano Palatino n. 1392 con facsimili. 16 p. (Pubblicazioni del Collegio alla Querce di Firenze, serie in-8—N. 21), Florence (1927). ISIS

Heffening, Willi. Zum Leben und zu den Schriften AN-NAWAWĪ's. *Der Islam* 22, 165-90, 1935. ISIS

Apropos of ABŪ ZAKARĪYĀ YAḤYĀ IBN SHARAF AL-NAWAWĪ (XIII-2); for whom see my *Introduction* 2, 1131. G. S.

Tea, Eva. WITELO, prospettico del secolo XIII. *L'arte* 30, 3-30, 1927. ISIS

This careful study should have been mentioned in my *Introduction* (vol. 2, 1027-28). It is divided as follows: 1. WITELO; 2. Le fonti di WITELO; 3. La metafisica di WITELO; 4. La psicologia di WITELO; 5. Analisi della visione; 6. Gli inganni dell'occhio; 7. L'estetica di WITELO; 8. WITELO e il dolce stil nuovo. G. S.

Thompson, C. J. S. Apothecaries in England in the thirteenth century. *Proceedings of the royal society of medicine, section of the history of medicine* 28, 19-22, London, 1934-35. ISIS

THOMPSON has discovered in the State papers, British Museum, the names of three apothecaries who flourished in England in 1264 and 1265. They are ROBERT DE MONTE PESOLANO of Westminster, PHILIP of the Abbey of the Holy Cross, Gloucester, and REGINALD OF HEREFORD. Their names occur in connection with a series of bills or accounts for drugs and preparations supplied, together with the quantities and prices. These tables are reproduced by THOMPSON and the drugs analyzed. The previous earliest record of an apothecary in England is of JOHN DE SPICER, Mayor of York, 1273. THOMPSON, also, gives details about the guild of Apothecaries, Pepperers and Spicers, which was not divided into separate bodies until the end of the fourteenth century. H. R. V.

XIVth Century (whole and first half)

Ferretti, Giovanni. I due tempi della composizione della *Divina commedia*. 457 p. (Biblioteca di cultura moderna). Bari, LATERZA, 1935. ISIS

Kämpf, Hellmut. PIERRE DUBOIS und die geistigen Grundlagen des französischen Nationalbewusstseins um 1300. VIII+114 p. (*Beiträge z. Kulturgesch. d. Mittelalters u. d. Renaissance*, 54). Leipzig, TEUBNER, 1935. ISIS

Reviewed by R. HOLTZMANN, *DLZ* 6, 2098-2100, 1935.

Pazzini, Adalberto. Il dottrinale medico nell' " Acerba " di CECCO D'ASCOLI. *Boll. Ist. stor. ital. arte sanit.* 14, 230-49, 274-92, 1934. ISIS

Sarton, George. A plague treatise by ABNER OF BURGOS? Query no. 55. *Isis* 24, 430, 1936. ISIS

Schneider, Theophora. Der intellektuelle Wortschatz Meister ECKEHARTS. Ein Beitrag zur Geschichte des deutschen Sprachinhalts. 130 p. (*Neue Dtsch. Forschgn. Abt. Dt. Philol.*, 1). Berlin, JUNKER & DÜNNHAUPT, 1935. ISIS

Reviewed by ADOLF KORN, *DLZ* 57, 577-79, 1936.

Thompson, Daniel V., jr. More medieval color-making: *Tractatus de coloribus* from Munich, Staatsbibliothek, MS. Latin 444. *Isis* 24, 382-96, 1936. ISIS

This Munich treatise represented by a fourteenth century MS. provides a link between the thirteenth century Caius College MS edited by D. W. SINGER (*Isis* 13, 5-15, 1929) and the fifteenth century Paris MS edited by the author (*Isis* 22, 456-68, 1935). "It is probably safe to assume that the Munich text represents a version of an original *Tractatus qualiter quilibet artificialis color fieri possit* (from which the Paris text was an abridged transcript), though its title, found only in the explicit, is simply *Tractatus de coloribus*." G. S.

XIVth Century (second half)

Bensa, Enrico. FRANCESCO DI MARCO DA PRATO. Notizie e documenti sulla mercatura italiana del secolo XIV. XXXIII+487 p. Milano, fratelli Treves, 1928. ISIS

Reviewed by LÉON MIROT, *Journal des savants*, 200-13, 1935.

Kimble, George H. T. The Laurentian world map with special reference to its portrayal of Africa. *Imago mundi* 1, 29-33, facs., 1935. ISIS

"There would appear to be good reason for retaining 1351 as the approximate date of the original drawing and for regarding the African outlines as the work of later editors: the first dating possibly from the period of the de Virga world map and the second from the period of Portuguese activity along the west African coasts. This view, it is claimed, takes cognisance both of available facts and the prevailing geographical theories. It is in harmony too with palaeographical opinion concerning the period of the script. Apart from some such explanation the Laurentian world map must remain an enigma, for neither the 14th nor early 15th century holds any record of achievement that can account for so substantial a change in geographical ideas as is exhibited in its coloured rendering of the African continent."

Plimpton, George A. The education of CHAUCER. Illustrated from the schoolbooks in use in his time. IX+176 p., 47 pl. London, Oxford University Press, 1935. ISIS

Description of some of the treasures of the author's library concerning CHAUCER with abundant facsimiles, and index of proper names and astrological terms in CHAUCER. G. S.

Somogyi, Joseph de. A history of the Caliphate in the Ḥayāt al-ḥayawān of ad-Damīrī. *Bulletin of the school of oriental studies* 8, 143-55, 1935. ISIS

Rolleston, J. D. CHAUCER and mediaeval medicine. Comptes rendus du IX^e Congrès internat. d'histoire de la méd. 14, IX. 1932. 12 p. Bukarest, FURNICA, 1935. ISIS

XVth Century (whole and first half)

Collard, Auguste. Magister JACOBUS ANGELUS DE ULMA et son "Tractatus de cometis." II^e Congrès national des sciences, p. 82-88, Bruxelles, 19-23 juin 1935. ISIS

JACOBUS D'ANGELUS était originaire d'Ulm et fils d'un pharmacien. Il étudia à Paris en 1382 et à Vienne en 1391. Il écrivit un *Tractatus de cometis* à l'occasion de la fameuse comète de 1402. Ce traité fut imprimé à Ulm en 1480. L'auteur analyse le traité et discute la comète de 1402. G. S.

Gukovskij, M. Die Mechanik von L. B. ALBERTI und die Mechanik von LEONARDO DA VINCI. *Archives of the history of science and technology* 7, 105-28, Leningrad, 1935 (in Russian, with German summary). ISIS

Thorndike, Lynn. Another manuscript of LEONARD OF BERTIPAGLIA and JOHN DE TRACIA. *Bulletin of the institute of the history of medicine* 4, 257-60, 1936. ISIS

XVth Century (second half)

Kinkeldey, Otto. Music and music printing in incunabula. *Papers of the bibliographical society of America*, 26, 89-118, 1932. ISIS

Klebs, Arnold C. Gleanings from incunabula of science and medicine. *Papers of the bibliographical society of America* 26, 52-88, 1932. ISIS

Paoli, Umberto Giulio. Sulla storia della scoperta dell'America. *Archeion* 17, 518-21, 1935 (received April 1936). ISIS

Read, Thomas T. Mineral technology: fifteenth century. *Papers of the bibliographical society of America* 26, 119-27, 1932. ISIS

Smith, David Eugene. The influence of the mathematical works of the fifteenth century upon those of later times. *Papers of the bibliographical society of America* 26, 143-71, 1932. ISIS

Thorndike, Lynn. JOHN TOLHOPF again. *Isis* 24, 419-21, 1936. ISIS

Further biographical information in addition to that published in *Isis* 22, 229, 1934. G. S.

XVIth Century (whole and first half)

A. — *Mathematics*

Harig, G. CARDANS und TARTAGLIAS Streit um die kubischen Gleichungen und seine gesellschaftlichen Grundlagen. *Archives of the history of science and technology* 7, 67-104, Leningrad, 1935 (in Russian with German summary). ISIS

B. — *Physical sciences and technology*

Buczek, Karol. Ein Beitrag zur Entstehungsgeschichte der " Kosmographie " von SEBASTIAN MÜNSTER. *Imago mundi* 1, 35-40, port., 1936. ISIS

Hooykaas, R. Die Elementenlehre des PARACELSUS. *Janus* 39, 175-87, 1935. ISIS

" In this paper we have been aiming at an elucidation of what PARACELSUS actually meant in using the word element. To this purpose we had to draw a clear distinction between his *Archidoxa* and his other works. Evidently the word element as used by him has to be taken in four different meanings, which are to be coordinated two by two. By making this distinction it has also become possible to bring out clearly the connexion between the four elements and the three principia. In this way new light may possibly be cast upon the origin of the post-paracelsian doctrine of the five principia, as we shall attempt to do in our next article."

Koyré, Alexandre. NICOLAS COPERNIC. Des révolutions des orbes célestes. Traduction, avec introduction et notes. VIII+156 p. Paris, ALCAN, 1934. ISIS

Reviewed by EDWARD ROSEN, *Isis* 24, 439-42, 1936.

Wagner, Henry R. The manuscript atlases of BATTISTA AGNESE. *Papers of the bibliographical society of America* 25, 1-110, 16 pl., 1931. ISIS

D. — *Medical sciences*

Baumgartner, Leona ; Fulton, John F. A bibliography of the poem

Syphilis sive morbus Gallicus by GIROLAMO FRACASTORO of Verona. 157 p., 9 fig., frontispiece. New Haven, Yale University Press, 1935. ISIS

Reviewed by GEORGE SARTON, *Isis* 24, 437-39, 1936.

Viets, Henry R. ANDREW BORDE, peripatetic physician (c. 1490-1549). *New England journal of medicine* 214, 380, 1936. ISIS

E. — *Alia*

Ford, J. D. M. Cronica de Dom JOÃO DE CASTRO by LEONARDO NUNES. Edited with an introduction. XXVIII+241 p. Cambridge, Mass. Harvard University Press, 1936. ($ 2.50). ISIS

Edition of this chronicle from a MS which after many vicissitudes has found its final resting place among the treasures of the Harvard Library. JOÃO DE CASTRO (1500-48) was a famous governor then viceroy of the Portuguese empire in India. The edition has been prepared with great care, but unfortunately there is no index. G. S.

Pogo, Alexander. NARDI or KIRCHER? Query no. 56. *Isis* 24, 430-1, 1 facs., 1936. SIS

Apropos of A. KIRCHER's *Œdipus ægyptiacus* (Rome, 1654-5) reproducing a page from JACOPO NARDI's (1476-1563) *Museum Gaddianum* (?), when and where was that work published? G. S.

XVIth Century (second half)

B. — *Physical sciences and technology*

Wertheim, Hans. Der erste europäische Strassenatlas. *Imago mundi* 1, 41-44, 1935. ISIS

Apropos of the *Itinerarium orbis christiani*. "Die Herausgabe der ersten Ausgabe des Itinerarium, die in vier Heftchen nacheinander aus Licht gebracht wurde, beginnt in den siebziger Jahren des 16. Jahrhunderts. Der Titel des ersten Teiles enthält keine Jahreszahl. Der zweite Teil stammt aus dem Jahre 1579. Der Titel des dritten und vierten Teiles zeigt das Jahr 1580. Der Erscheinungsort ist nicht bekannt. Die oben zitierte Ausgabe aus dem Jahre 1598 ist zweifellos, wie erwähnt und aus dem Titel hervorgeht, in Köln erschienen." The first edition was probably published in Antwerp G. S.

D. — *Medical sciences*

Larkey, Sanford V. The Hippocratic oath in Elizabethan England. *Bulletin of the institute of the history of medicine* 4, 201-19, 8 fig., 1936. ISIS

Van Schevensteen, Dr. Notes biographiques sur JOANNES GOROPIUS BECANUS, médecin-philologue (1518-1573). Comptes rendus, II^e^ congrès national des sciences, 113-27, Bruxelles, 1935. ISIS

XVIIth Century (whole and first half)

B. — *Physical sciences and technology*

Cabanes, Charles. DENYS PAPIN, inventeur et philosophe cosmopolite. Préface de MAURICE D'OCAGNE. 287 p. Paris, Société française d'éditions littéraires et techniques, 1935 (15 fr.). ISIS

Biographie basée en partie sur des documents d'archives inédits. G. S.

Cannenburg, W. Voorbeijtel. An unknown " pilot " by HESSEL GERRITSZ, dating from 1612. *Imago mundi* 1, 49-51, maps, 1935. ISIS

Gambarov, A. I. Die wichtigsten technischen Ausrüstungen der Metallurgie Russlands im XVII. Jahrhundert. *Archives of the history of science and technology* 7, 181-227, Leningrad, 1935 (in Russian with German summary). ISIS

Koyré, A. A l'aurore de la science moderne : la jeunesse de GALILÉE. *Annales de l'Université de Paris* 10, 540-51, 1935 ; 11, 32-56, 1936. ISIS

Texte d'une conférence faite le 2 février 1935, devant le Comité belge d'Histoire des sciences à Bruxelles. J. P.

Maks, C. S. SALOMON DE CAUS (1576-1626). 131 p., frontispiece. Amsterdam, Centen's uitgevers-Maatschappij, 1 (S. d. préface datée La Haye, Oct. 1935) (Prix 5 fl.). ISIS

Cette étude, faite sous la direction du Dr. J. J. BLANKSMA, professeur de chimie organique à l'Université de Leyde, nous inspire confiance, car elle a été faite avec beaucoup de soin. Le premier chapitre nous décrit la vie errante de S. de Caus en Italie, Belgique, Angleterre, Allemagne et France. Le chapitre deux explique sa personnalité. Comme ce fut le cas pour beaucoup de ses contemporains, sa religion varia ; protestant d'origine, il a été au service des archiducs catholiques à Bruxelles et son mariage fut célébré dans une église catholique de Bruxelles et son fils y fut baptisé à Ste. Gudule. Cependant il mourut protestant (Paris, 1626). SALOMON fut un physicien, un ingénieur et un inventeur distingué, mais de second ordre. Mlle. MAKS discute minutieusement ses travaux (chapitres 3 à 5) et nous donne une bibliographie étendue. Son livre est

terriblement monotone et elle a la manie déplorable de faire un nouveau paragraphe presque de chaque phrase. Cependant elle a fait œuvre utile. G. S.

Nierenstein, M. The discovery of lactic sugar. *Isis* 24, 367-69, 1936. ISIS

The discovery is generally ascribed to BARTOLETI " who is supposed to have mentioned it for the first time in his *Encyclopaedia hermetico-dogmatica*... Bononiae, of which there were three editions, namely, 1615, 1619, and 1621. The date of the discovery of lactic sugar is therefore sometimes given as 1615 or 1619." However this cannot be substantiated. G. S.

Sarton, George. Early decimal instruments. Query no. 57. *Isis* 24, 432, 1936. ISIS

Taeschner, Franz. Das Hauptwerk der geographischen Literatur der Osmanen, KĀTIB ČELEBI's *Gihānnumā*. *Imago mundi* 1, 44-47, 1935. ISIS

Apropos of the *Jihānnumā* (or *Cosmorama*) of the Turkish polyhistor MUṢṬAFĀ IBN ABDULLĀH, called KĀTIB CHELEBI, also ḤĀJJĪ KHALĪFA (1609-57), which he twice began but never completed, and was only published, whatever there was of it, after his death. G. S.

Zoubov, V. Une théorie aristotélicienne de la lumière du XVII^e siècle. *Isis* 24, 343-60, 1 facs., 1936. ISIS

A propos of FORTUNIO LICETI (1577-1657): *De luminis natura et efficientia* (Udine, 1640). G. S.

E. — *Alia*

Anesaki, M. Psychological observations on the persecution of the Catholics in Japan in the seventeenth century. *Harvard journal of Asiatic studies* 1, 13-27, 1936. ISIS

Chalmers, Gordon Keith. Three terms of the corpuscularian philosophy. *Modern philology* 33, 243-60, 1936. ISIS

Apropos of the terms *effluvium*, *effluxion* and *emission* used by Sir THOMAS BROWNE. G. S.

Miller, Joseph L. A discussion of BURTON's " Anatomy of melancholy." *Annals of medical history* 8, 44-53, 1936. ISIS

XVIIth Century (second half)

B. — *Physical sciences and technology*

F., V. A. BEJTON und seine Karte von Amur. *Imago mundi* 1, 47-8, fig., 1935. ISIS

MacPike, Eugene Fairfield. Dr. EDMOND HALLEY's marriage and children. *Genealogical quarterly* 4, 4 p., 1935. ISIS

Paoli, Umberto Giulio. Il Marchese MARCO ANTONIO DE LA FRATTA E MONTALBANO (1635-1695). *Archeion* 17, 353-78, 8 fig., 1935 (received April 1936). ISIS

Rossiter, A. P.; Edwards, W. N. HOOKE as geologist. *Nature* 137, 455-56, 1936. ISIS

E. — *Alia*

Van Hée, L. (S. J.). L'Empereur K'ANG-HI (1662-1722) et les sciences européennes. Comptes rendus, IIe Congrès national des sciences; Bruxelles, 51-9, 1935. ISIS

Vogel, J. Ph. JOAN JOSUA KETELAAR of Elbing (1659-1718), author of the first Hindūstānī grammar. *Bulletin of the school of oriental studies* 8, 817-22, 1936. ISIS

XVIIIth Century (whole and first half)

A. — *Mathematics*

Godeaux, Lucien. Un précurseur belge de la géométrie projective : JACQUES-FRANÇOIS LE POIVRE. Comptes rendus, 2me Congrès national des sciences, 94-5, Bruxelles, 1935. ISIS

Le montois LE POIVRE (mort en 1710) publia le *Traité des sections du cylindre et du cône...* (Paris, 1704), et le *Traité des sections du cône considérées dans le solide* (Mons, 1708, réimprimé Mons, 1854), qui le place ainsi que son contemporain PHILIPPE DE LA HIRE (1640-1718) parmi les précurseurs de la géométrie projective. G. S.

Loria, Gino. Contributi matematici dati dal d'ALEMBERT all' " Encyclopédie méthodique." Actes, conférences et communications du IIIe congrès international d'histoire des sciences, tenu au Portugal en 1934, 15 p. Lisbon, 1935. ISIS

Loria, Gino. EULERO o i neo-pitagorici? Una questione di priorità. Estratto dal volume, *Studi in onore del Salvatore Ortu Carboni*, 8 p., Roma, 1935. ISIS

Apropos of polygonal numbers. G. S.

Nielsen, Niels (1865-1931). Géomètres français du dix-huitième siècle. Ouvrage posthume publié par les soins de N. E. NÖRLUND. 437 p. Copenhagen, LEVIN & MUNKSGAARD, 1935. ISIS

L'auteur de ce livre avait publié antérieurement une étude sur les *Géomètres français sous la révolution* (1929; *Isis* 16, 502), et deux livres sur les géomètres danois, *Matematiken i Danmark*, 1528-1800, 1801-1908. Le présent ouvrage posthume contient une série de biographies en ordre alphabétique : D'ALEMBERT (23 p.), JACQUES ALEXANDRE, D'ANVILLE (2 p.), D'ARCY (4 p.), etc.

G. S.

B. — *Physical sciences and technology*

(Gray, Stephen; d. 1736). STEPHEN GRAY : The first Copley medallist. *Nature* 137, 299, 1936. ISIS

Morison, Samuel Eliot. Old school and college books in the Prince library. *Bulletin of the Boston Public library* 11, 77-93, 3 facs., 1936. ISIS

" The Prince collection, in the custody of the Boston Public library, probably contains the best collection in existence of books used in the schools and colleges of New England from the early settlement of the Bay Colony to the middle of the eighteenth century. Even the great Plimpton collection in the city of New York, with more variety of titles, contains fewer books with association values than those to be found in the Prince Library. The following list is not inclusive; it only includes a few items that I have come across in browsing. THOMAS PRINCE probably prepared for college at the Boston Latin School, and he graduated from Harvard in 1707."

D. — *Medical sciences*

Castiglioni, Arturo. G. B. MORGAGNI and the anatomico-pathological conception of the clinic (abstract). *Proceedings of the royal society of medicine, section of the history of medicine* 28, 1-4, London, 1934-35. ISIS

Comrie, John D. English medicine in the eighteenth century. *Proceedings of the royal society of medicine, section of the history of medicine* 28, 37-44, London, 1934-35. ISIS

Hare, Tom. An F. Baker snuff-box belonging to an eighteenth century apothecary. *Proceedings of the royal society of medicine, section of the history of medicine* 28, 34-6, London, 1934-35. ISIS

Klotz, Oskar. ALBRECHT VON HALLER (1708-77). *Annals of medical history* 8, 10-26, 1936. ISIS

Meyer, A. W. The GASSER of the Gasserian ganglion. *Annals of medical history* 8, 118-23, 1936. ISIS

Apropos of JOHANN LUDWIG GASSER who flourished in Vienna about the middle of the eighteenth century. G. S.

Rowbotham, Arnold H. The " philosophes " and the propaganda for inoculation of smallpox in eighteenth-century France. *University of California publications in modern philology* 18, 265-90, 1935. ISIS

" The *philosophes's* championship of inoculation resolves itself into an attack on one of the gates of the citadel of l'*infâme*. It becomes one of the minor actions in the great war against intolerance and superstition." This is followed by a " chronological list of the chief works and events in the controversy over inoculation in France (1713-75)." G. S.

XVIIIth Century (second half)

A. — *Mathematics*

Loria, Gino. LAGRANGE nelle Accademia di Berlino e Parigi. Dal volume : ANTON MARIA LORGNA, *Memorie pubblicate nel secondo centenario dalla nascita*, a cura dell' Accademia di Agricoltura scienze lettere di Verona, 10 p., Verona, 1935. ISIS

Ver Eecke, Paul. Le traité des Hosoèdres de VITO CARAVELLI. Traduit sur le texte latin original. *Mathesis* 24 p., 8 fig., 1935. ISIS

The Neapolitan mathematician VITO CARAVELLI (1724-1800) wrote so many mathematical textbooks that he is known only as a textbook maker and a commentator on EUCLID. However in 1751, he published a short treatise on hosoedra, wherein he developed with considerable originality ideas first explained by NICOLO DI MARTINO in 1728 (not 1768). That short treatise is translated in extenso. G. S.

B. — *Physical sciences and technology*

Rostovzov, I. La voiture mécanique de KOULIBINE. *Archives of the history of science and technology* 7, 375-97, 15 fig., Leningrad, 1935 (In Russian, with French summary). ISIS

" Parmi les manuscrits du mécanicien autodidacte russe du XVIII[e] siècle I. P. KOULIBINE, on a découvert au Musée Historique de Moscou plusieurs dessins graphiques d'une voiture mécanique de son invention. KOULIBINE avait projeté trois variantes d'une voiture mécanique à quatre et trois roues. Se basant sur les fragments de quelques dessins graphiques l'auteur a essayé

de reproduire la construction du mécanisme. Il s'arrête sur les traits originaux de cette construction : le volant, le frein à ressort, la boîte de changement de vitesses et les paliers à disques."

Vassiljev, S. F. The theory of matter and the foundations of classical mechanics in KANT's philosophy. *Archives of the history of science and technology* 7, 1-65, Leningrad, 1935. (In Russian with English summary). ISIS

" This article gives a short exposition of the fundamental notions of the Kantian philosophy and its social tendencies, traces the evolution of the philosopher's conceptions of the mathematical doctrine of natural history, discusses the the Kantian foundations of the dynamical theory of matter and of classical mechanics, and, lastly, by comparing KANT's conceptions with those of BOSCOVICH on the one hand and of EULER on the other, determines KANT's position in the strife between the dynamical and kinetical standpoints in physics of the 18th century."

Zabarinskij, P. P. ALEXANDER SMITH's " water-pumping steam engine." *Archives of the history of science and technology* 7, 429-72, Leningrad, 1935 (in Russian, with English summary). ISIS

" This paper describes the design and construction of a small atmospheric engine built in 1791-1792 for the needs of the Port of Cronstadt after the plans of an English master ALEXANDER SMITH. The fact of the construction of this plant has up till now remained quite unknown and has nowhere been noted in literature. This engine was one of the first steam engines built in Russia."

C. — *Natural sciences*

Garboe, Axel. Zwei kleine süddeutsche Städte und ihre Beziehung zur Geschichte der Vererbungsforschung. *Janus* 39, 189-95, 6 fig., 1935. ISIS

Mainly apropos of J. G. KÖLREUTER (1733-1806).

Miller, Genevieve. Unpublished autographs in the Welch medical library. *Bulletin of the institute of the history of science* 4, 243-46, 1936. ISIS

THOMAS MARTYN (fl. 1760-1816). Natural history draughtsman and pamphleteer.

D. — *Medical sciences*

Barnard, Cyril C. The *Epistola invitatoria* (1776) of JOHANN PETER FRANK. Translated by CYRIL C. BARNARD. *Janus* 39, 149-64, 1935. ISIS

Beekman, Fenwick. Studies in aneurysm by WILLIAM and JOHN HUNTER. *Annals of medical history* 8, 124-37, 1936. ISIS

Lemay, Pierre. Un projet d'assurances médicales au XVIII^e^ siècle. *Bull. de la soc. franç. d'hist. de la méd.* 30, 30-6, 1936. ISIS

Levinson, Abraham. DOMENICO COTUGNO. *Annals of medical history* 8, 1-9, 6 fig., 1936. ISIS

Monteiro, Arlindo Camilo. Les doctrines médicales de JOHN BROWN au Portugal et en Espagne. *Archeion* 17, 379-400, 1935 (received April 1936). ISIS

Roddis, Louis H. WILLIAM WITHERING and the introduction of digitalis into medical practice. *Annals of medical history* 8, 93-112, 1 fig., 1936. ISIS

Rouffiandis, M. le Dr. Les rapports de la société populaire de Perpignan avec le service de santé de l'armée des Pyrenées-orientales (1793-94-95). *Bull. de la soc. franç. d'hist. de la méd.* 30, 37-48, 1936. ISIS

E. — *Alia*

Libby, Margaret Sherwood. The attitude of VOLTAIRE to magic and the sciences. 299 p. New York, Columbia University Press, 1935. ISIS

Reviewed by ROBERT K. MERTON, *Isis* 24, 442-44, 1936.

XIXth Century (whole and first half)

A. — *Mathematics*

Pelseneer, J. QUETELET, CHASLES et les faux VRAIN-LUCAS, d'après des lettres inédites. Comptes rendus, 2me congrès national des sciences, 105-12, Bruxelles, 19-23 juin, 1935. ISIS

B. — *Physical sciences and technology*

(Berzelius, J. J.). Bibliographie de J. J. BERZELIUS. Publiée au nom de l'Académie royale des sciences de Suède par ARNE HOLMBERG, première partie : Ouvrages imprimés, supplément, VIII + 37 p. Seconde partie, manuscrits, XVI + 221 p. Stockholm, 1936. ISIS

Ces deux volumes terminent la bibliographie dont le premier volume a paru en 1933 (*Isis* 23, 527). Elle a été fait avec beaucoup de soin et de minutie. L'auteur a réuni les éléments d'une iconographie berzélienne qui paraîtra plus tard. La Suède cultive la reconnaissance et sait honorer ses grands hommes. L'académie des sciences suédoise a fait son devoir pour BERZELIUS; cela lui a été relativement facile grâce au dévouement et à l'érudition du Dr. HOLMBERG. G. S.

De Brandner, G. Les méridiennes de QUETELET. *Ciel et terre* 51, 203-6, 1935. J. P. ISIS

Iscoldskij, I. I. A forgotten theory on the structure of matter (The theory of M. G. PAVLOV). *Archives of the history of science and technology* 7, 357-65, 4 fig., 1935 (in Russian with English summary). ISIS

" The author discovered in the Manuscript department of the Lenin Library a small copybook of the lectures of M. G. PAVLOV, professor of physics and agriculture at the Moscow University (1793-1840). As his manuscript shows M. G. PAVLOV expounded the following postulates already in the thirties of the 19th century: 1) Movement is the dominating factor. 2) Light is of an electrical nature. 3) All substances have originated from a primary matter. 4) All substances consist of oxygen and hydrogen. 5) The structure of matter is associated with its electric charge. 6) The elements have a planetary structure. 7) The first element consists of + and — charges. M. G. PAVLOV had thus anticipated with his theory many scientists of later times and he must be considered the predecessor of the present day theory of the structure of matter."

Le Verrier, M.-L.; Casevitz, Th. MORSE, peintre de LA FAYETTE. *L'Illustration* 94, 18 ill., 1936. ISIS

Ocagne, Maurice d'. THOMAS DE COLMAR, inventeur de l'arithmomètre. *Revue scientifique* 73, 783-85, 1935. J. P. ISIS

Roger, P. La " loi " de DALTON en chimie. *L'enseignement scientifique* 9, 129-39, 1936. ISIS

Yamamoto, Issei. KUNITOMO's sun-spot observations during 1835-1836. Bulletin published by the Kwasan Observatory, Kyoto Imperial University 4, 3, 1935. ISIS

We shall soon publish in *Isis* an article on KUNITOMO by the same author. G. S.

D. — *Medical sciences*

Drogendijk, A. C. Het dagboek van Vrouw WALTMAN, vroedvrouw

in de 19de eeuw te Dordrecht. *Bijdragen tot de geschiedenis der geneeskunde* 16, 33-40, 1936. ISIS

Apropos of the Dutch midwife WILLEMINA WALTMAN (1802-74). G. S.

Faucci, Ugo. In memoria di AGOSTINO BASSI (1775-1856) (Nel 1° centenario del " ... Mal del Segno ") (1835-1935). *Rivista di storia delle scienze mediche* 27, 1-26, 1936. ISIS

Macneill, Norman. Infant welfare as taught in Philadelphia one hundred years ago. *Annals of medical history* 8, 36-43, 1936. ISIS

Underwood, E. Ashworth. The history of the 1832 cholera epidemic in Yorkshire. *Proceedings of the royal society of medicine, section of the history of medicine* 28, 5-18, London, 1934-35. ISIS

Epidemic in the East in 1817, cholera appeared in England in 1831. The next year saw 1960 deaths in Yorkshire, one-half of them in Leeds. The disease, in 1832, was entirely unknown to British practitioners. Sanitary reform began shortly after this epidemic. The author gives an excellent account of both the disease and the sanitary conditions of the city, with a full list of references to contemporary medical reports. H. R. V.

XIXth Century (second half)

A. — *Mathematics*

Desforge, J.; Iliovici, G.; Robert, P. L'Œuvre de M. JACQUES HADAMARD et l'enseignement secondaire. *L'enseignement scientifique* 9, 97-117, 1936. ISIS

B. — *Physical sciences and technology*

(Brillouin, Marcel). Jubilé scientifique de M. MARCEL BRILLOUIN. Allocutions prononcées à la cérémonie du 17 décembre 1935. 40 p. Paris, GAUTHIER-VILLARS, 1936. ISIS

Allocutions prononcées par MM. JOSEPH BÉDIER, EMILE PICARD, CH. MAURAIN, PAUL LANGEVIN, J. PERRIN et MARCEL BRILLOUIN. J. P.

Cerasoli, Ercole. Sulla origine della stereochimica. *Archeion* 17, 401-04, 1935 (received April 1936). ISIS

Fischer, Josef (S. J.). Autobiographische Darstellung des Lebensganges und des wissenschaftlichen Lebenswerkes. *Imago mundi* 1, 58-61, 1935. ISIS

Holmes, Harry N. A great pupil and a great discovery, both supported by a great teacher. *Science* 83, 175-77, 1936. ISIS

Apropos of CHARLES MARTIN HALL's industrial process for the extraction of aluminium (1886). G. S.

McKie, Douglas. Personalities in physics. *Nature* 137, 419-21, 1936. ISIS

Rayleigh, Lord. Some reminiscences of scientific workers of the past generation, and their surroundings. *Proceedings of the physical society* 48, 217-46, 1936. ISIS

Presidential address, delivered January 24, 1936. These very precious reminiscences concern Lord KELVIN, the Royal Institution, Sir WILLIAM CROOKES, Sir ARTHUR SCHUSTER. G. S.

Zehnder, Ludwig. W. C. RÖNTGEN. Briefe an L. ZEHNDER. Mit den Beiträgen Geschichte seiner Entdeckung der Röntgenstrahlen und RÖNTGENS Einstellung zur Renaissance der klassischen Physik. 198 p., portraits. Zürich, RASCHER, 1935. ISIS

"Schon viele Veröffentlichungen über RÖNTGEN, über seinen Lebenslauf und seine Leistungen sind erschienen, auch von mir. Ich nenne nur meine beiden bezüglichen Aufsätze in 'A. CHROUST, Lebensläufe aus Franken' Band IV, Würzburg, 1930, und in 'Helvetica physica acta' VI. Jahrg, Basel, 1933, sowie das vortreffliche reichhaltige Buch von OTTO GLASSER in Cleveland über RÖNTGEN, mit einem Beitrag 'Persönliches über RÖNTGEN' von MARGRET BOVERI in Berlin, erschienen bei J. SPRINGER, Berlin, 1931 (*Isis* 22, 256-59). Bei Gelegenheit von RÖNTGENS 90. Geburtstag, am 27. März 1935, und vom 40. Jahr seiner grossen Entdeckung will ich hier die wichtigsten, interessantesten seiner Briefe an mich und auch einige meiner Briefe an ihn sowie ein paar auf die Geschichte seiner Entdeckung bezügliche Briefe in ihrem Wortlaut veröffentlichen. Sie sind Dokumente für die bisherigen Schriften über RÖNTGEN und über die Geschichte seiner Entdeckung, weil doch viel zu viel Legenden über die Art seiner Entdeckung gebildet worden sind. Nur ein reichliches Dutzend von RÖNTGENS Briefen reproduziere ich hier nicht, solche nämlich, die für die Allgemeinheit kein grösseres Interesse haben, sowie ein paar Briefe, deren Inhalt noch lebende Zeitgenossen RÖNTGENS unangenehm empfinden könnten. Aber keinen dieser Röntgenbriefe unterdrücke ich, der *mich* persönlich irgendwie belastet. Denn ich erstrebe möglichste Vollständigkeit in dieser Publikation der Briefe von RÖNTGEN, um dessen wahren, vornehmen Charakter ins rechte Licht zu setzen."

C. — *Natural sciences*

Carpenter, G. D. Hale. Three unpublished letters of CHARLES DARWIN. *Nature* 137, 400, 1936. ISIS

" CHARLES DARWIN wrote several letters to WILLIAM BENJAMIN CARPENTER, five of which have been published in the ' Life and letters.' The original MSS., eight in number, came to me on the death of my uncle, JOSEPH ESTLIN CARPENTER, the last surviving son of WILLIAM BENJAMIN, and I have presented them to Down House for preservation by the British Association."

Kniasev, G. A.; Kniaseva, M. F. The scientific relations of I. M. SECHENOV and the Russian Academy of Sciences. *Archives of the history of science and technology* 7, 399-427, Leningrad, 1935 (in Russian, with English summary). ISIS

Osborn, Henry Fairfield (Aug. 8, 1857-Nov. 6, 1935). Tributes paid at memorial meetings in New York City, November 7, November 12, and December 18, 1935. *Supplement to Natural history* 37, 14 p., 1936. ISIS

D. — *Medical sciences*

Policard, Pr. Commémoration du centenaire de LOUIS RANVIER (1835-1922). *Bull. de la soc. franç. d'hist. de la méd.* 30, 49-52, 1936. ISIS

Roudin, Mata B.; Moschowitz, Eli. The unpublished poems of "In hospital" by WILLIAM ERNEST HENLEY. *Bulletin of the institute of the history of medicine* 4, 231-41, 2 fig., 1936. ISIS

Sigerist, Henry E. A fee bill of the Georgia medical society, revised in 1863. *Bulletin of the institute of the history of medicine* 4, 333, 1 facs., 1936. ISIS

XXth Century

D. — *Medical sciences*

Viets, Henry R. STEPHEN D'IRSAY (1894-1934). *Isis* 24, 370-74, 1936. ISIS

Biography of the Hungarian physician, historian of science and medicine who died prematurely in Paris, 1934. G. S.

Weisberger, Siegfried. Doctor RUHRAH at home. *Bulletin of the institute of the history of medicine* 4, 221-29, 2 fig., 1936. ISIS

Apropos of the late Dr. JOHN RUHRAH of Baltimore.

E. — *Alia*

Furnas, C. C. The next hundred years. The unfinished business of science. XIV+434 pp., Baltimore, The WILLIAMS & WILKINS Company, 1936 ($3.00). ISIS

The author is a professor of chemical engineering at Yale, who has undertaken the rather large task of surveying the fields of biology, chemistry, and physics, not only as to their remarkable developments in the modern period but also as to their trends which indicate future accomplishments; at least, he sifts out of the maze of achievements those problems which are now calling for solution. Such surveys as this become valuable source books for the future historian of science and its applications, since they afford a record of the existing status of scientific theories and the extent of their applications. The biological field is ably presented in its biochemical aspects but, as often happens with the chemically trained thinker, he fails to realize that there are any biological problems which have other than chemical aspects. C. A. K.

Grierson, Sir George. Indian and Iranian studies presented to GEORGE ABRAHAM GRIERSON on his eighty-fifth birthday, 7th January, 1936. VII + p. 297-880, portrait, 4 pl. London School of oriental studies 1936. ISIS

Forming vol. VIII parts 2 and 3 of the Bulletin of The School of oriental studies (University of London). Including a portrait and bibliography. G. S.

Kishimoto, Hideo. Professor WOODS and his last visit to Japan. *Harvard journal of Asiatic studies* 1, 7-12, 1936. ISIS

JAMES HAUGHTON WOODS (1864-1935), portrait.

Nature. Science in the XXth century. Special number reviewed by GEORGE SARTON, *Isis* 24, 433, 1936. ISIS

Zetterstéen, K. V. Volume dédié à l'ancien éditeur du *Monde oriental*, M. le Professeur K. V. ZETTERSTÉEN. A l'occasion du 65me anniversaire de sa naissance le 18 août 1931. XII+321 p. *Le Monde Oriental*, vol. 25, Uppsala, Lundequistska Bokhandeln, 1931. ISIS

PART II

HISTORICAL CLASSIFICATION

I. — ANTIQUITY

1. — ANTIQUITY
(*Generalities*)

Baumann, E. D. Über den Boulimos und die Fames canina. *Janus* 39, 165-74, 1935. ISIS

Brunet, Pierre ; Mieli, Aldo. Histoire des sciences. Antiquité. 1224 p., 109 fig. (Bibliothèque scientifique). Paris, PAYOT, 1935. ISIS

Reviewed by GEORGE SARTON, *Isis* 24, 444-47, 1936.

Labriolle, Pierre de. La réaction païenne. Etude sur la polémique antichrétienne du Ier au VIe siècle. 519 p. Paris, L'Artisan du Livre, 1934. ISIS

Lutz, Henry Frederick. Speech consciousness among Egyptians and Babylonians. *Osiris* 2, 27 p., 1936. ISIS

Sarton, George. Minoan mathematics. *Isis* 24, 375-81, 6 facs., 1936. ISIS

Apropos of Sir ARTHUR EVANS : *Palace of Minos* (London, MACMILLAN, 1921-35). G. S.

2. — EGYPT

Černý, Jaroslav. Semites in Egyptian mining expeditions to Sinai. *Archiv orientální* 7, 384-89, 5 fig., 1935. ISIS

Glanville, S. R. K. Some recent excavations in Egypt. *Antiquity* 10 77-85, 1936. ISIS

Svenonius, Björn. On the orientation of the Egyptian pyramids. 9 p. (Historical notes and papers, nr. 5). Meddelande från Lunds astronomiska observatorium, nr. 80, Lund, 1936. ISIS

Temkin, Owsei. Recent publications on Egyptian and Babylonian medicine. *Bulletin of the institute of the history of medicine* 4, 247-56, 1936. ISIS

3. — BABYLONIA AND ASSYRIA

Temkin, Owsei. Recent publications on Egyptian and Babylonian medicine. *Bulletin of the institute of the history of medicine* 4, 341-47, 1936.

4. — GREECE

Méautis, Georges. Les mystères d'Eleusis. 92 p., figs., plates, map. Neuchatel, Editions de la Baconnière, 1934. ISIS

Depuis 1619 quand JOANNES MEURSIUS publia le premier livre consacré à Eleusis beaucoup d'autres ont paru. Celui-ci est un modèle de bonne vulgarisation scientifique. L'auteur a adopté en partie la théorie de MARTIN P. NILSSON (*The Minoan-Mycenaean religion and its survival in Greek religion*, Lund, 1928; *Isis* 12, 394). G. S.

Robert, Fernand. Epidaure. 46 p., 20 pl. Paris, Société d'édition Les belles lettres, 1935. ISIS

5. — ROME

Dunning, G. C. ; Jessup, R. F. Roman barrows. *Antiquity* 10, 37-53, 6 pl., 2 fig., 1936. ISIS

Sergeienko, M. E. Contribution à l'histoire de la culture des olives dans l'Italie ancienne. *Archives of the history of science and technology* 7, 325-55, Leningrad, 1935 (In Russian with French summary). ISIS

II. — MIDDLE AGES

6. — MIDDLE AGES
(*Generalities*)

Arendt, W. W. Zur Geschichte der Artillerie im Mittelalter. *Archives of the history of science and technology* 7, 297-323, Leningrad, 1935 (in Russian with German summary). ISIS

" Der Verfasser stellt sich die Aufgabe, die Sammlung älterer Hinterlader des Historischen Artilleriemuseums in Leningrad dem wissenschaftlichen Verkehr zugänglich zu machen. Durch Vergleich seines seltenen Materials

mit den in westeuropäischen Sammlungen war es möglich, neue, Beiträge zum Problem der Entstehung dieses Geschütztypus zu liefern wobei folgendes abgeleitet werden konnte: Die ältesten Kammerlader, dieses erste Geschützsystem, sind ihrer Entstehung nach als Seeartillerie anzusehen. Diese Konstruktion wurde in der Marineartillerie bis zum Ausgang des 16. Jahrhunderts beibehalten. Als Überbleibsel findet man die Kammerlader bis Anfang des 18. Jahrhunderts im nahen Orient und ein Jahrhundert später noch in der Schiffsbewaffnung des fernen Ostens. In Bezug auf die Entstehung des alten Veugler kommen wir zu der Schlussfolgerung, dass die Konstruktion dieses 'Instrumentes' mit der des Siphon, der byzantinischen 'Marineartillerie' (ebenso wie das Pulver mit dem 'ignis graecus') verwandt gewesen ist."

Hare, Tom. Some contributions to mediaeval veterinary science in the Kitāb al-falāhah and in Fleta. *Proceedings of the royal society of medicine, section of the history of medicine* 28, 27-34, London, 1934-35. ISIS

Includes nothing new. G. S.

MacKinney, L. C. "Dynamidia" in medieval medical literature. *Isis* 24, 400-14, 1936. ISIS

"During the Middle Ages the term *dynamidia* (meaning the virtues of medical substances or treatments) enjoyed a technical significance and usage that it has not had in earlier and later ages. Many other medieval expressions, for instance, *herbaria*, *antidotaria*, *receptaria*, *dieta*, *butanica*, *pharmaceutica*, and *cirurgia*, have survived. But the word *dynamidia* is conspicuously absent from modern, as well as from ancient, medical literature."

Thorndike, Lynn. Little known names of medical men in Vatican Palatine manuscripts. *Annals of medical history* 8, 145-59, 1936. ISIS

Uhden, Richard. Die antiken Grundlagen der mittelalterlichen Seekarten. *Imago mundi* 1, 1-20, map, 1935. ISIS

III. — ORIENTAL SCIENCE AND CIVILIZATION

8. — WESTERN ASIA

Thureau-Dangin, F. Un comptoir de laine pourpre à Ugarit d'après une tablette de Ras-shamra. *Syria* 15, 137-46, 1934. ISIS

Virolleaud, Ch. Fragments d'un traité phénicien de thérapeutique hippologique provenant de Ras-shamra. *Syria* 15, 75-83, 2 fig., 1934. Note de E. DHORME, ibidem, p. 304. ISIS

CENTRAL ASIA

Ünver, A. Süheyl. Uygurlarda Tababet (La médecine chez les Ouigours). 87 p., 8 plates (Istanbul Üniversitesi tib tarihi enstitüsü, 3). Istanbul 1936 (in Turkish with French summary). ISIS

Elaborate account of Uighûr medicine which was undertaken by the professor of medical history in the university of Istanbul, because our Turkish friends are anxious to know as well as possible their ethnic and intellectual ancestry. The Uighûr were apparently the most gifted branch of the Turkish race. Their influence can still be traced in the medical folklore of Anatolia (drugs and words). The author considers that the many resemblances between Uighûr traditions and those of the Western Turks afford another proof of their identical origin. The existence of many Hindu words in Uighûr writings is noteworthy. The scientific (or non-magical) character of Uighûr medicine is also very remarkable. G. S.

EASTERN ASIA

(Including works relative to the whole of Buddhist Asia, or to India, Central and Eastern Asia combined)

Eliade, Mircea. Alchimia asiatică, I. 74 p. Bucharest Cultura Poporului, 1935. ISIS

Reviewed by the author, *Archeion* 17, 462-64, 1935 (received April 1936).

Harvard Journal of Asiatic studies. Edited by SERGE ELISSÉEFF, CHARLES S. GARDNER, and JAMES R. WARE. Volume I, number 1, JAMES HAUGHTON WOODS memorial number, 161 p. Cambridge, Mass., Harvard-Yenching Institute, 1936. ISIS

We greet with special pleasure the new journal published by the Harvard Yenching Institute, 17 Boylston Hall, Cambridge, Mass. The articles of interest to our readers will be regularly analyzed in *Isis*. Our best wishes to the new journal and its distinguished staff. G. S.

Pogo, Alexander. Cylindrical and diagonal calendars. Query no. 54. *Isis* 24, 429-30, 1 fig., 1936. ISIS

Apropos of the astronomical knowledge of the Battak (N. Sumatra). How is it connected with Malay lore on the one hand, and with Hindu astronomy on the other?

9. — INDIA

Bloch, Jules. La charrue védique. *Bulletin of the school of oriental studies* 8, 411-18, 1936. ISIS

Filliozat, M. J. Les états typhoides et comateux dans la médecine et les croyances populaires indiennes. *Bull. de la soc. franç. d'hist. de la méd.* 30, 21-29, 1936. ISIS

Vogel, J. Ph. A standard work on Indian architecture. *Acta orientalia* 14, 224-30, 1936. ISIS

Apropos of PRASANNA KUMAR ACHARYA's edition and translation of the *Mânasâra* (*Isis* 4, 615; 13, 212; 17, 552; 24, 501). G. S.

10. — CHINA

Chatley, Herbert. Chinese planetary observations. *Nature* 137, 461, 1936. ISIS

Hummel, Arthur W. (editor). Some eminent Chinese of the seventeenth century. Twenty-two biographies from a proposed dictionary of CH'ING dynasty biography. IV+21 p. Baltimore, Waverly Press, 1936. ISIS

These 22 biographies contributed by 18 authors have been compiled as far as I can judge with considerable care. They make me wish that the whole work, or at least the seventeenth century part of it may soon be completed and published. The printing—Chinese as well as European type—is fine. This is a splendid undertaking which does credit to the individual scholars and to their leaders ARTHUR W. HUMMEL and MORTIMER GRAVES. It is interesting to note that no less than 180 collaborators —American, Chinese and Japanese—have already been enlisted. I hope they will receive all the help which they badly need and fully deserve. G. S.

Kuo, Chan-po. Hsien-ch'in-pien-hsüeh-shih. VI+264 p. Shanghai, Chung Hwa Book Co., 1932. ISIS

Reviewed by W. EICHHORN, *OLZ* 39, 183-86, 1936. History of logical schools in the early CH'IN time.

12. — ISRAEL

(*Including works devoted to Palestine*)

Abel, Félix Marie. Géographie de la Palestine, t. I, Géographie physique et historique. XXV+515 p., 16 fig., 17 pl., 12 maps. Paris, GABALDA, 1933. ISIS

Aešcoly-Weintraub, Aaron Z. Introduction à l'étude des hérésies religieuses parmi les Juifs. La kabbale. Le hassidisme. Essai critique. LI+205 p. Paris, GEUTHNER, 1928. ISIS

Alt, Albrecht. Die Ursprünge des israelitischen Rechts. 72 p. (Berichte über die Verhandl. der Sächs. Akademie der Wiss. zu Leipzig, philol-histor. Kl., 86). Leipzig, HIRZEL, 1934. ISIS

Alt, Albrecht. Palästinajahrbuch des Deutschen evangelischen Instituts für Altertumswissenschaft des Heiligen Landes zu Jerusalem. 122 p., 1 map, 8 fig. ; 103 p., 5 fig. Berlin, Mittler, 1931-33. ISIS

Assaf, S. Gaonica. Gaonic responsa and fragments of halachic literature from the Geniza and other sources. 238 p. (in Hebrew). Jerusalem, 1933. ISIS

Auerbach, Elias. Wüste und Gelobtes Land. Geschichte Israels von den Anfängen bis zum Tode SALOMOS. XII+307 p., 18 pl. Berlin, WOLFF, 1932. ISIS

Baikie, James (1866-1931). Ancient Jerusalem. 90 p., ills. (Peeps at ancient civilizations). London, BLACK, 1930. ISIS

Barton, George Aaron. Semitic and Hamitic origins, social and religious. XVI+395 p. Philadelphia, University of Pennsylvania Press, 1934. ISIS

Barton, George Aaron. Archaeology and the Bible. Part I : The Bible lands, their exploration, and the resultant light on the Bible and history. Part II : Translations of ancient documents which confirm or illuminate the Bible. XVII+598 p., 135 pl. Philadelphia, American Sunday-School Union, 1933. ISIS

Bension, Ariel. The Zohar in Moslem and Christian Spain. With an introduction by Sir DENISON ROSS. XXII+256 p. London, ROUTLEDGE, 1932. ISIS

Billen, Albert Victor. The old Latin texts of the Heptateuch. VIII+234 p. Cambridge, University Press, 1927. ISIS

Brauer, Erich. Ethnologie der jemenitischen Juden. XIX+402 p., 8 pl. Heidelberg, WINTER, 1934. ISIS

Brierre-Narbonne, Jean-Joseph. Exégèse talmudique des prophéties messianiques. 120 p. Paris, GEUTHNER, 1934. ISIS

Castells, Francis de Paula. Prehistoric man in Genesis. A study in Biblical anthropology giving the true reading of the first chapters of the Bible and a naturalistic interpretation of the tradition about ADAM and EVE. 160 p. London, RIDER, 1929. ISIS

Cohen, Abraham. Le Talmud. Exposé synthétique du Talmud et de l'enseignement des rabbins sur l'éthique, la religion, les coutumes et la jurisprudence. Trad. par J. MARTY, 464 p. Paris, 1933. ISIS

Cohen, Abraham. Everyman's Talmud. XLI+420 p. London, DENT, 1932. ISIS

Cohon, Beryl D. Ethics of the Rabbis. Based on Pirke Aboth. With brief biographies of the more famous sages of the Mishnah and the Hebrew text of Aboth. 156+XXXII p. Boston, CHAPPLE, 1932. ISIS

Cook, Stanley Arthur. The place of the Old Testament in modern research. An inaugural lecture delivered on 18 May 1932. 47 p. Cambridge, University Press, 1932. ISIS

Dalman, Gustaf. Arbeit und Sitte in Palästina. Bd. II : Der Ackerbau. Bd. III : Von der Ernte zum Mehl. Ernten, Dreschen, Worfeln, Sieben, Verwahren, Mahlen. XVI+384 p. XI+339 p., 71 fig. ; Bd. IV : Brot, Öl und Wein. XIV+452 p., 112 ills. 81 fig. ; Gütersloh, BERTELSMANN, 1932, '33, '35. ISIS

Dammann, Günther. Die Juden in der Zauberkunst (Jüdische Zauberkünstler). Eine Biographiensammlung. Mit einem Vorwort von WALTER PHILIPP. 2. Auflage. 101 p. Berlin, DAMMANN, 1933 ISIS

De Haas, Jacob. History of Palestine : the last two thousand years. XXVII+523 p. New York, MACMILLAN, 1934. ISIS

Diringer, David. Le iscrizioni antico-ebraiche Palestinesi. XXIX+361 p., 30 pl. Firenze, 1934. ISIS

Einstein, Albert. About Zionism. Speeches and letters. Translated and edited, with an introduction, by LEON SIMON. London, Soncino Press, 1930. ISIS

Eisenstein, Judah David. Ozar wa-yekuhim. A collection of polemics

and disputations (in Hebrew), with a general introduction and a special foreword to each article, annotations and full indexes. 384 p. New York, 1928. ISIS

Engberg, Robert M.; Shipton, Geoffrey M. Notes on the chalcolithic and early Bronze Age pottery of Megiddo. XIII+91 p., fig. (Oriental Inst. of the University of Chicago, Studies in ancient oriental civilization, 10). Chicago, University Press, 1934. ISIS

Fichtner, Johannes. Die altorientalische Weisheit in ihrer israelitisch-jüdischen Ausprägung. Eine Studie zur Nationalisierung der Weisheit in Israel. VIII+128 p. (Beihefte zur Zeitschrift für die Alttestamentl. Wissenschaft, 62). Giessen, TÖPELMANN, 1933. ISIS

Friedman, Lee Max. Early American Jews. XIV+238 p. Cambridge, Harvard University Press, 1934. ISIS

Garstang, John. The heritage of SOLOMON: an historical introduction to the sociology of ancient Palestine. XV+439 p., 4 pl.(HERBERT SPENCER's descriptive sociology, 3). London, WILLIAMS & NORGATE, 1934. ISIS

Garstang, John. Joshua, Judges. XXIV+423 p. (The foundation of Bible history). London, CONSTABLE, 1931. ISIS

(Gaster, Moses). The Samaritan oral law and ancient traditions. Vol. I: Samaritan eschatology. The belief of the Samaritans in immortality, resurrection, future punishment and reward. The Taheb and the Second Kingdom, translated from hitherto unedited manuscripts by MOSES GASTER. IX+277 p. London, Search Publishing Co., 1932. ISIS

Gaster, Moses. Studies and texts in folk-lore, magic, mediaeval romance, Hebrew apocrypha and Samaritan archaeology. With fourteen plates and five illustrations. Collected and reprinted. 3 volumes. London, MAGGS, 1925-28. ISIS

Ginzberg, Louis. Midrash and haggadah. XVII+8+549 p. (Genizah studies in memory of Doctor SOLOMON SCHECHTER, I). New York, Jewish Theological Seminary of America, 1928. ISIS

Ginzberg, Louis. The legends of the Jews. I. From the creation

to JACOB, 1909. II. From JOSEPH to the Exodus, 1910. III. From the Exodus to the death of MOSES, 1911. IV. From JOSHUA to ESTHER, 1913. V. Notes to volumes I and II, 1925. VI. Notes to volumes III and IV, 1928. Philadelphia, Jewish Publication Society of America. ISIS

Glatzer, Nahum Norbert. Untersuchungen zur Geschichtslehre der Tannaiten. Ein Beitrag zur Religionsgeschichte. VI+126 p. Berlin, SCHOCKEN, 1933. ISIS

Goldschmidt, Lazarus. Der babylonische Talmud. Nach der ersten zensurfreien Ausgabe unter Berücksichtigung der neueren Ausgaben und handschriftlichen Materials neu übertragen. III. Bd.: Joma, Sukka, Tom Ṭob, Rosh Hashana, Ta'anith. V+750 p. IV. Bd.: Megilla; Moe'd qaṭan, Hagiga, Jabmuth. VI+765 p. V. Bd.: Kethubot, Nedarim, Nazir. 693 p. Berlin, Jüdischer Verlag, 1930-31. ISIS

Gressmann, Hugo (1877-1927). Der Messias. 506 p. (Forschgn. z. Relig. u. Literat. d. Alten u. Neuen Testam. Hrsg. v. RUD. BULTMANN u. HERM. GUNKEL. Neue Folge, H. 26 D. ganzen Reihe 43. H.). Göttingen, VANDENHOECK, 1929. ISIS

Guttmann, Alexander. Das redaktionelle und sachliche Verhältnis zwischen Mišna und Tosephta. Preisgekrönte Lösung der Lewy-Preisfrage. VIII+196 p. Breslau, MARCUS, 1928. ISIS

Guttmann, Jacob. Die Philosophie des Judentums. 412 p. (Kafka: Geschichte der Philosophie in Einzeldarstellungen. Abtg. 1, Bd. 3). München, REINHARDT, 1933. ISIS

Hempel, Johannes. Die althebräische Literatur und ihr hellenistisch-jüdisches Nachleben. 203 p., figs., pl. (Handbuch d. Literaturwiss.). Wildpark-Potsdam, Akadem. Verlagsgegesellsch. Athenaion, 1930-34. ISIS

Herford, Robert Travers. Talmud and Apocrypha. A comparative study of the Jewish ethical teaching in the Rabbinical and non-Rabbinical sources in the early centuries. IX+323 p. London, Soncino Press, 1933. ISIS

Herrman, Louis. A history of the Jews in South Africa from the earliest times to 1895. 287 p. London, GOLLANCZ, 1930. ISIS

Hooke, Samuel Henry. Myth and ritual. Essays on the myth and ritual of the Hebrews in relation to the culture pattern of the ancient East by A. M. BLACKMAN, C. J. GADD, F. J. HOLLIS, S. H. HOOKE, E. O. JAMES, W. O. E. OESTERLEY, T. H. ROBINSON. Foreword by D. C. SIMPSON. XIX+204 p. London, MILFORD, 1933. ISIS

Idelsohn, Abraham Zebi. Jewish music in its historical development. XIV+535 p. New York, HOLT, 1929. ISIS

Irwin, Clarke Huston. The Bible, the scholar and the spade. A summary of the results of modern excavation and discovery. 251 p. London, R. T. S., 1932. ISIS

Jarvis, Claud S. Yesterday and today in Sinai. 312 p., 28 pl., 1 map. Edinburgh, BLACKWOOD, 1931. ISIS

Kaplan, Julius. The redaction of the Babylonian Talmud. VII+356 p. New York, BLOCH, 1933. ISIS

Katzenstein, Julius. History and destiny of the Jews. Translated from the German by HUNTLEY PATERSON. VIII+464 p. London, LANE, 1933. ISIS

Kennett, Robert Hatch. Ancient Hebrew social life and custom as indicated in law, narrative and metaphor. VI+114 p. (The Schweich lectures of the British Academy, 1931). London, Oxford University Press, 1933. ISIS

Kittel, Rudolf (1853-1929). Gestalten und Gedanken in Israel. Geschichte eines Volkes in Charakterbildern. 2. Aufl. XII+536 p. Leipzig, QUELLE & MEYER, 1932 (1. Aufl., 1925). ISIS

Klatzkin, Jakob. Thesaurus philosophicus linguae Hebraicae et veteris et recentioris. Pars prima. 338 p. Berlin, Eschkol, 1928 (In Hebrew). ISIS

Klausner, Joseph. A history of modern Hebrew literature (1785-1930). Authorised translation from the Hebrew by HERBERT DANBY. Edited by LEON SIMON. V+204 p. London, CAILINGOLD, 1932. ISIS

Kleinman, Moses. Demuyot we-komot (Portraits and personalities). 336 p. (in Hebrew). London, MAZIN, 1930. ISIS

Twenty essays on modern Hebrew literature and on the influence exerted by the revival of Hebrew Jewish life and thought from the era of the Haskalah to the rise of Zionism. G. S.

Koeppel, Robert (S. J.). Palästina. Die Landschaft in Karten und Bildern. v+174 p., 150 phot., 34 diag., 34 maps. Tübingen, MOHR, 1930. ISIS

Krautheimer, Richard. Mittelalterliche Synagogen. 285 p., 100 ill. Berlin, FRANKFURTER, 1927. ISIS

Lagrange, Marie Joseph. Le Judaïsme avant Jésus-Christ. XXVII+624 p. (Etudes bibliques). Paris, GABALDA, 1931. ISIS

Lebeson, Anita Libman. Jewish pioneers in America, 1492-1848. X+372 p. New York, BRENTANO, 1931. ISIS

Lods, Adolphe. Les prophètes d'Israël et les débuts du Judaïsme. XXIII+434 p., 8 pl. (L'Evolution de l'humanité). Paris, La Renaissance du Livre, 1935. ISIS

Mann, Jacob. Texts and studies in Jewish history and literature. Vol. II : Karaitica. XXIII+1600 p., 4 facs. Philadelphia, Jewish publication society of America, 1935. ISIS

Marcus, Jacob Rader. The rise and destiny of the German Jew, XVIII+417 p. Cincinnati, Union of American Hebrew Congregations, 1934. ISIS

Maynard, John Albert. The birth of Judaism. A study of Hebrew religion during the Exile. 144 p. London, LUZAC, 1928. ISIS

Meyerhof, Max. Le temple du Vieux-Caire et sa Guéniza. *Archeion* 17, 527, 1935 (received April 1936). ISIS

Neuville, René. Les débuts de l'agriculture et la faucille préhistorique en Palestine. Extrait du Recueil de la Société Hébraïque d'Exploration et d'Archéologie Palestiniennes, Jérusalem, 1934. ISIS

Newman, J. The agricultural life of the Jews in Babylonia between the years 200 C.E.-500 C.E. XII+215 p. London, Oxford University Press, 1932. ISIS

Newman, Louis Israel ; Spitz, Samuel. The Hasidic anthology. Tales and teachings of the Hasidim. The parables, folktales, fables, aphorisms, epigrams, sayings, anecdotes, proverbs, and exegetical interpretations of the Hasidic masters and disciples ; their lore and wisdom. Translated from the Hebrew, Yiddish, and German, selected, compiled and arranged. With an introduction on " The Hasidim, their history, literature and doctrines." XCI+720 p. New York, SCRIBNER'S, 1934. ISIS

Obermeyer, Jacob. Die Landschaft Babylonien im Zeitalter des Talmuds und des Gaonats. Geographie und Geschichte nach talmudischen, arabischen und anderen Quellen. VIII+362 p., 2 maps (*Schriften der Gesellschaft zur Forderung der Wissenschaft des Judentums*, Nr. 30). Frankfurt a.M., KAUFFMANN, 1929. ISIS

Oesterley, William Oscar Emil ; Robinson, Th. H. A history of Israel. Vol. 1 : From the Exodus to the fall of Jerusalem, 586 B.C. by TH. H. ROBINSON. Vol. 2 : From the fall of Jerusalem to the Bar-Kokhba-Revolt, A.D. 135 by W. O. E. OESTERLEY. XVI+496 p., 1 map ; XVI+500 p. Oxford, Clarendon Press, 1932. ISIS

Parkes, James William. The conflict of the Church and the Synagogue. A study in the origins of antisemitism. London, Soncino Press, 1934. ISIS

Perlow, Towa. L'éducation et l'enseignement chez les Juifs à l'époque talmudique. 13+122 p. Paris, LEROUX, 1931. ISIS

Petrie, Sir William M. Flinders. Palestine and Israel : historical notes. 99 p., 16 pl. London, Society for Promoting Christian Knowledge, 1934. ISIS

Petrie, Sir William M. Flinders. Ancient Gaza I-IV. VII+15 p., 62 pl. ; VIII+18 p., 59 pl. ; VII+15 p., 54 pl.; VII+21 p., 70 pl. (British school of archaeology in Egypt). London, QUARITCH, 1931-34. ISIS

Preis, Karl. Die Medizin in der Kabbala. 20 p. (Schriften der Gesellschaft zur Förderung der Wissenschaft des Judentums, Nr. 35). Frankfurt a.M., KAUFMANN, 1928. ISIS

Rosenbaum, M. ; Silbermann, A. M. Pentateuch with Targum Onkelos, Haphtaroth and prayers for Sabbath and RASHI'S

commentary. Translated into English and annotated. In collaboration with A. BLASHKI and L. JOSEPH. London, Shapiro, VALLENTINE, 1933. ISIS

Ruppin, Arthur. The Jews in the modern world. With an introduction by L. B. NAMIER. XXXI+423 p. (Studies in modern history). London, MACMILLAN, 1934. ISIS

Sarachek, Joseph. The doctrine of the Messiah in mediaeval Jewish literature. XII+339 p. New York, Jewish Theological Seminary of America, 1932. ISIS

Saye, Hymen. Medical excerpts from Sefer Mif'alot Elokim (The book of God's deeds). JOEL BA'AL SHEM and NAPHTALI KATZ. Translated by HYMEN SAYE. *Bulletin of the institute of the history of medicine* 4, 299-331, 1936. ISIS

JOEL BEN ISAAC HEILPRINN (JOEL BA'AL SHEM I) and NAPHTALI KATZ (1640-1719) were "wonder-rabbis," and the *Sefer mif'alot elokim* (The book of God's deeds) was first published in 1724 in Zolkiew, Poland. For this very interesting phase of Jewish life see JACOB S. MINKIN: *The romance of Hassidism* (New York, 1935; *Isis* 25, 159-64). We are much indebted to HYMEN SAYE for enabling us to study the medical side of that movement. G. S.

Schwarz, Karl. Die Juden in der Kunst. 228 p., 50 pl., 9 fig. Berlin, Welt-Verlag, 1928. ISIS

Stummer, Friedrich. Monumenta historiam et geographiam Terrae Sanctae illustrantia, quas recensuit et notis illustravit. Series prima. VI+94 p. (Florilegium patristicum tam veteris quam medii aevi auctores complectens, fasc. xli). Bonn, HANSTEIN, 1935. ISIS

Sukenik, Eleasar Lipa. Ancient synagogues in Palestine and Greece. 90 p., ills., 19 pl. London, 1934. ISIS

Sukenik, Eleazar Lipa. The ancient synagogue of Beth Alpha. An account of the excavations conducted on behalf of the Hebrew University, Jerusalem. From the Hebrew. 58 p., 28 pl. Jerusalem, University Press, 1932. ISIS

Vilnay, Zev. Legends of Palestine. XIV+492 p., 69 illus. Philadelphia, Jewish Publication Society of America, 1932. ISIS

Watzinger, Carl. Denkmäler Palästinas. Eine Einführung in die

Archäologie des Heiligen Landes. I : Von den Anfängen bis zum Ende der israelitischen Königszeit. VIII+117 p., 10 fig., 40 pl. Leipzig, HINRICHS, 1933. ISIS

Waxman, Meyer. A history of Jewish literature. From the close of the Bible to our own days. Vol. I : From the close of the Canon to the end of the twelfth century. XVI+501 p., 8 ills. Vol. 2, From the twelfth century to the middle of the eighteenth century. X+698 p., 4 ills. New York, BLOCH, 1930-1933. ISIS

Wolf, Lucien (1857-1930). Essays in Jewish history. Edited by CECIL ROTH. London, Jewish historical society of England, 1934. ISIS

Yahuda, Abraham Shalom. The language of the Pentateuch in its relation to Egyptian. Vol. 1. XXXVIII+310 p., 16 pls. London, Oxford University Press, 1933. ISIS

Yahuda, Joseph. Law and life according to Hebrew thought. 229 p. London, Oxford University Press, 1932. ISIS

14. — ISLAM

(*Also Arabia*)

Blachère, R. Extraits des principaux géographes arabes du moyen âge. 392 p. (Bibliotheca arabica, 7). Paris, GEUTHNER, 1932. ISIS

Reviewed by GEORGE SARTON, *Isis* 24, 447-49, 1936.

Hennig, R. Der mittelalterliche arabische Handelsverkehr in Osteuropa. *Der Islam* 22, 239-65, 1935. ISIS

Mainz, Ernst. Mu'tazilitische Ethik. *Der Islam* 22, 191-206, 1935. ISIS

PART III

SYSTEMATIC CLASSIFICATION

I. — SCIENCE IN GENERAL

16. — HISTORY OF SCIENCE

Académie internationale d'histoire des sciences. *Isis* 24, 435-36, 1936. ISIS

Gardedieu, Alex. L'enseignement de l'histoire des sciences en Belgique. Comptes rendus, II[e] Congrès national des sciences, Bruxelles, 131-37, 1935. ISIS

Mieli, Aldo. Historiens de la médecine et historiens de la science. *Archeion* 17, 405-09, 1935 (received April 1936). ISIS

Apropos of SARTON's The history of science versus the history of medicine (*Isis* 23, 313-320, 1935). MIELI is generally in agreement with SARTON. G. S.

Ocagne, Maurice D'. Hommes et choses de science, propos familiers, Troisième série. 275 p. Paris, VUIBERT, 1936 (15 fr.). ISIS

Rainov, T. I. Fundamental scientific discoveries. *Sorena* No. 9, 84-95. No. 10, 82-96, 1935. (In Russian). ISIS

A discussion of the development of such discoveries as the theory of relativity, the electromagnetic phenomena, the non-Euclidean geometries, etc. Conclusions: "Fundamental scientific discoveries, however great, are unable, *per se*, to attract the attention of contemporaries and to stir their creative activity; they do not, *per se*, stimulate the development of science. Only the addition of certain conditions—which lie "outside" the field of science—enables these discoveries to exert an influence on the development of science." A. P.

Sarton, George. The history of science and the problems of to-day. III+30 p. (Elihu Root lectures of Carnegie Institution of Washington on the influence of science and research on current thought). Washington, 1936. ISIS

Lecture delivered in Washington on Dec. 10, 1935.

Sarton, George. Second preface to volume XXIV. Two fundamental problems. *Isis* 24, 308-09, 1936. ISIS

The two fundamental problems are the humanization of industry and labor and the humanization of science. These two problems are correlative. Preface dated Lisbon, Sept. 27, 1934. G. S.

Sarton, George. Carnegie Institution of Washington, Division of historical research, Section of the history of science. Seventeenth annual report for the period extending from July 1, 1934 to June 30, 1935. *Isis* 24, 422-28, 1936. ISIS

Contents: 1. Generalities, 2. Introduction to the history of science, 3. Maya astronomy, 4. Other investigations, 5. Editing of *Isis*, 6. Center of research in the history of science and learning, Lectures, Staff, Bibliography.

Sarton, George. Forty-fourth critical bibliography of the history and philosophy of science and of the history of civilization (to end of May 1935:—with special reference to India). *Isis* 24, 468-536, 1936. ISIS

"This forty-fourth Bibliography contains about 410 items of which 67 deal with India. They have been kindly contributed by ten scholars belonging to 4 different countries."

Woodbury, Robert S. Courses at the Massachusetts Institute of Technology, Cambridge, Mass. *Isis* 24, 432, 1936. ISIS

18. — PHILOSOPHY OF SCIENCE

Metzger, Hélène. Réflexions sur le Congrès international de philosophie scientifique (Paris, Sorbonne, 15-25 septembre 1935). *Archeion* 17, 421-23, 1935 (received April 1936). ISIS

Morris, Charles W. First international congress for the unity of science. *Isis* 24, 433-34, 1936. ISIS

II. — FORMAL SCIENCES
(Knowledge of forms)

20. — MATHEMATICS

Libois, P. De l'espace métrique à l'espace projectif. Comptes rendus, 2me congrès national des sciences 96-104, Bruxelles, 1935. ISIS

1. L'espace abstrait; 2. L'espace des géomètres grecs; 3. Peintres et

architectes italiens; 4. KÉPLER; 5. DESARGUES; 6. MONGE; 7. PONCELET; 8. MÖBIUS; 9. VON STAUDT; 10. Le postulat des parallèles et la géométrie projective; 11. Synthèse de l'espace métrique et de l'espace projectif.

Loria, Gino. La préparation théorique et pratique des professeurs de mathématiques de l'enseignement secondaire dans les divers pays. Rapport général. *L'enseignement mathématique* 32, 5-20, 1933. ISIS

Loria, Gino. Problemi matematici e metodi di risoluzione. Rendiconti della unione dei professori, 6, 295-6, 1935. ISIS

III. — PHYSICAL SCIENCES
(Knowledge of inorganic nature)

24. — PHYSICS

Crew, Henry. The rise of modern physics. Second edition. XIX+434 p. Baltimore, WILLIAMS & WILKINS, 1935. ISIS

Reviewed by V. F. LENZEN, *Isis* 24, 449-50, 1936.

Planck, Max. The philosophy of physics. Translated by W. H. JOHNSTON. 118 p. London, ALLEN and UNWIN, 1936. ISIS

26. — TECHNOLOGY

(*For mining, see* 32. *geology*; *for industrial chemistry*, 25. *chemistry*. *See also Arts and crafts, under* 45)

Gilfillan, S. C. Inventing the ship. A study of the inventions made in her history between floating log and rotor ship. 294 p., 80 fig. Chicago, FOLLETT, 1935. ISIS

Reviewed by ABBOTT PAYSON USHER, *Isis* 24, 450-53, 1936.

Kamenskij, B. A. Russian metallurgical industry in the pictures of the 18th and first half of the 19th century. *Archives of the history of science and technology* 7, 229-96, Leningrad, 1935 (in Russian, with English summary). ISIS

IV. — BIOLOGICAL SCIENCES
(Knowledge of organic nature)

27. — BIOLOGY
(*Generalities*, " *Natural history* ")

Lameere, Aug. Histoire de l'expression " biologie." Comptes rendus, II^e Congrès national des sciences Bruxelles, 128-30, 1935. ISIS

Pearl, Raymond. Historical papers in the journal " Human biology." *Isis* 24, 415-18, 1936. ISIS

28. — BOTANY

(Agronomy, phytopathology, palaeobotany)

Jacob, Heinrich Eduard. Coffee. The epic of a commodity. Translated from the German by EDEN and CEDAR PAUL. XIII + 296 p., 38 pls. New York, The Viking Press, 1935. ($3.50). ISIS

WILLIAM HARVEY, the discoverer of the circulation of the blood, bequeathed (1657) to the London College of Physicians the greatest treasure of his laboratory, namely, fifty-six pounds of coffee, directing that his colleagues should assemble month by month to commemorate the day of his death by drinking together " this little fruit, the source of happiness and wit." The author traces the migration of the coffee-drinking habit from Arabia to Istanbul and thence to Vienna by way of the Turkish siege. Then ensued a long contest for favor between trimethyldioxypurin, the alkaloid refined from the coffee bean by RUNGE in 1820, and Bacchus. The spread of coffee houses in Germany and France so threatened the popularity of beer and wine that Venus was enlisted among the enemies of the " wine of Islam." It was at first sold in drug stores and regarded as a medicament. The Great Elector, FREDERICK WILLIAM, became interested in coffee through his Dutch physician, BUNTEKUH, who was interested in the effects of coffee on the circulation (*Menschenleven*, 1684) and in HARVEY's discoveries and he later recommended its use in his *Traktat von het excellentie kruyt thee, coffi, schokolate*. THÉVENOT's *Relation d'un voyage fait au Levant* (1665) did much to relieve coffee of the stigma of being a poison and a drug, by his accounts of its use as a social beverage among the Eastern peoples. Coffee may have had a part, especially among leaders who foregathered in the coffee houses in social, political, and scientific centers and preëminently in the 17th and 18th centuries in stimulating intellectual activity.

C. A. KOFOID.

Landon, Fred. The agricultural journals of upper Canada (Ontario). *Agricultural history* 9, 167-75, 1935. ISIS

29. — ZOOLOGY

von Hofsten, N. From CUVIER to DARWIN. A page from the history of comparative anatomy. *Isis* 24, 361-66, 1936. ISIS

" Who is the founder of comparative anatomy or comparative morphology, if this word is preferred? SEVERINO, VICQ D'AZYR, CAMPER, HUNTER, CUVIER, GEOFFROY ST. HILAIRE have been mentioned. No definite answer can be given." " When one turns from GEOFFROY ST. HILAIRE and OWEN to DARWIN, one enters a new world of ideas. With DARWIN there is no trace of *Naturphilosophie* and hardly any feeling for the unity of nature which

brought many other biologists to the border line of the idea of evolution. Hardly any morphological points of view will be found in his writings. Only when his theory of evolution was completed did he note, naturally with satisfaction, that it explained homologies. His attitude was, characteristically enough, not exactly that the facts of morphology prove a common descent, but rather that the theory of natural *selection* gives an explanation of the facts of morphology."

V. — SCIENCES OF THE EARTH

(Implying knowledge of both organic and inorganic nature)

31. — GEOGRAPHY AND OCEANOGRAPHY

Cortesão, Armando Cartografia e cartógrafos portugueses dos séculos XV e XVI (Contribuição para um estudo completo). 2 vol. XLIV+391 p., 455 p., 58 fig. Lisbon, Ediç. da " Seara Nova," 1935. ISIS

Reviewed by A. FONTOURA DA COSTA, *Archeion* 17, 476-78, 1935 (received April 1936) and by ROBERTO ALMAGIÀ, 478-98. This second review includes a list of 184 fifteenth and sixteenth century maps, and a list of 43 Portuguese cartographers of the sixteenth century.

Curschmann, Fritz. Die schwedischen Matrikelkarten von Vorpommern und ihre wissenschaftliche Auswertung. *Imago mundi* 1, 52-7, maps, 1935. ISIS

Imago mundi : Jahrbuch der alten Kartographie, Yearbook of old cartography, LEO BAGROW, HANS WERTHEIM, Herausgeber-editors. 84 p., pls. Berlin, 1935. ISIS

This first volume is analyzed in our 47th Critical Bibliography, and the following will be analyzed in the same manner. G. S.

Kamal, Prince **Youssouf.** Quelques éclaircissements épars sur mes Monumenta cartographica Africae et Aegypti. Imprimés pour l'auteur par E. J. BRILL. Leiden, 1935 (Non mis dans le commerce). ISIS

Reviewed by DANA B. DURAND, *Isis* 24, 453-55, 1936.

Karpinski, Louis C. Cartographical collections in America. *Imago mundi* 1, 62-64, 1935. ISIS

VI. — ANTHROPOLOGICAL AND HISTORICAL SCIENCES

(Knowledge of man, past and present)

34. — ANATOMY

Rolleston, J. D. Penis captivus : A historical note. *Janus* 39, 196-202, 1935. ISIS

" In the present paper the term ' penis captivus ' is applied to incarceration of the organ in the vagina due to psychogenic spasmodic contraction of the levator ani, and not to the condition resulting from insertion of the penis into rings and similar inanimate objects."

35. — PHYSICAL ANTHROPOLOGY

(*Anthropometry and races of man*)

Seiffert, Walter. Die Erbgeschichte des Menschen. Eine Vortragsfolge über die erbbiologische Stellung des Menschen als Gattung, Rasse und Persönlichkeit. 176 p., 108 fig. Stuttgart, ENKE, 1935. ISIS

This is a summary of the evolution of man and of the origin of the peoples and races of Europe. The last half of the book deals with the method and factors in evolution, hybridization, racial intermixture, and race culture. It is a defense of the thesis that the Nordic race is the most progressive race known to mankind. It is a document of historical significance setting forth the biological arguments for recent political and cultural movements in Germany by one of its scientific proponents. C. A. K.

36. — PHYSIOLOGY

(*Human and comparative*)

Arnett, John H. The vital capacity of the lungs. Early observations and instruments. *Medical life* 43, 3-6, 4 fig., 1936. ISIS

Hoff, H. E. Vagal stimulation before the WEBERS. *Annals of medical history* 8, 138-44, 1936. ISIS

Kanner, Leo. Historical notes on rumination in man. *Medical life* 43, 27-60, 12 illus., 1936. ISIS

" One of the most astonishing features of the history of rumination, or merycism, in man consists in the fact that its occurrence has not been recorded in adults until the beginning of the seventeenth century, and in children until the nineteenth century. No mention of the condition is to be found in the writings of Greek, Roman, and Arabic physicians. It has completely escaped the notice of HIPPOCRATES, GALEN, CELSUS, RHAZES, AVICENNA, and their many commentators. Curiously enough, it has found no entry into the vast realm of medical folklore, from which hardly any function or dysfunction of the human body has been excepted."

39. — PREHISTORY

Buttler, Werner. Pits and pit-dwellings in Southeast Europe. *Antiquity* 10, 25-36, 1 pl., 10 fig., 1936. ISIS

From the *Bonner Jahrbücher* 139, 134-44, Darmstadt, 1934, by permission of the Editor.

Carénou, Charles. L'art dolménique, architecture, sculpture, déchiffrement de la stèle néolithique de Mané er H'roek. 42 p. Paris, GEUTHNER, 1935. ISIS

Wainwright, G. A. The coming of iron. *Antiquity* 10, 5-24, 3 pl., 1936. ISIS

"Iron was originally known through its occurrence in meteorites. As meteorites are not, even yet, fully distinguished from thunderbolts, iron was, and in many places still is, considered a dangerous substance. Its supposed explosive powers were used magically in Egypt for some thousands of years before smelted iron was at all wellknown. During these ages it had been called *bia*, and curiously enough it was not until smelted iron was being imported that in the 14th century the addition *ni-pet* 'of the sky' was added. Although an occasional object of iron may be found, it is not until after the 15th century that one may expect to meet with iron here and there in Egypt. Actually Egypt was the last country of the Near East to enter the Iron Age, and then only under an intensification of northern influences. While Mesopotamia had known meteoric iron from before 3000 B.C. it also knew smelted iron as early as some time before 2800 B.C. But until 1100 B.C. iron was evidently as rare there as in Egypt. From the 20th century onwards Asia Minor had used iron regularly, some of it apparently meteoric, and here lived the important ironworkers of Kizzuwadna and Tabal-Tubal, as well as the Chalybes, and the inhabitants of the city called by the Greeks ἡ σιδηρᾶ. The name of the second of these nations is to be found in the Sumerian *tibira* "a smith"; while the third gave its name to a good quality iron in Greek; and, as some think, Asia Minor provided the Semites with their word for iron, *parzillu, barzel.* From the 15th century onwards Asia Minor, north Syria, and northwest Mesopotamia had exported iron objects, largely daggers and dagger-blades, though iron was still much used in jewellery. In this district the storm-god of Doliche was somehow connected with iron. It was clearly the wanderings of the Asianic tribes in the 14th and 13th centuries that brought the Iron age to Palestine. By 1100 B.C. Assyria, Carchemish, Cyprus, and Greece and the Aegean, were entering the Iron Age, and by the 8th century SARGON of Assyria had laid up in his storehouses 150 tons or so of good iron. His ingots were of the curious shape which 200 years later was entering Germany and France with the La Tène period of the Iron Age. Evidently the knowledge of iron-working did not radiate only to the south."

40. — ETHNOLOGY

(Primitive and popular science)

Corlett, William Thomas. The medicine-man of the American Indian and his cultural background. IX+369 p., frontispiece, 22 ills. Springfield, Ill., THOMAS, 1935. ISIS

Reviewed by CHAUNCEY D. LEAKE, *Isis* 24, 455, 1936.

Leyder, Jean. Association primitive d'idées : serpent-jumeaux-arc-en-ciel au Congo belge. Comptes rendus, 2me Congrès national des sciences, 39-44, Bruxelles, 1935. ISIS

" L'association primitive d'idées : serpent-jumeaux-arc-en-ciel permet de relever chez toute une série de peuplades soudanaises du Congo belge l'existence d'une mentalité logique caractérisée. La mentalité mystique n'est pas absente mais plus rare. L'étude prudente et précise des faits la fait apparaître maintes fois comme une tentative d'explication logique mais maladroite, et dont les erreurs sont dues à l'insuffisance de la technique, au manque de sens critique et, par suite, non à la mentalité spéciale mais à l'ignorance des primitifs."

Marinus, Albert. Ethnographie, folklore et archéologie en Russie soviétique. *Bull. de la société royale belge d'anthropologie et de préhistoire* 49, 173-86, 1934. ISIS

Marinus, Albert. Caractéristiques du mouvement folklorique en Belgique. *Le folklore brabançon* 15, 12 p., Bruxelles, 1936. ISIS

Marinus, Albert. Thèses folkloriques. *Le folklore brabançon*, 15, 7 pl., Bruxelles, 1936. ISIS

Mazzini, Giuseppe. La medicina nel Cile, prima della conquista spagnola. *Rivista di storia delle scienze mediche* 27, 27-34, 1936. ISIS

Wright, Jonathan. The medicine of primitive man—XXV. *Medical life* 43, 75-120, 1936. ISIS

43. — SOCIOLOGY, JURISPRUDENCE AND POSITIVE POLITY

Pareto, Vilfredo. The mind and society (*Trattato di sociologia generale*, 1916). Edited by ARTHUR LIVINGSTON. Translated by ANDREW BONGIORNO and ARTHUR LIVINGSTON with the advice and active cooperation of JAMES HARVEY ROGERS. 4 vols., 2033 p. New York, HARCOURT, BRACE, 1935. ISIS

Reviewed by GEORGE C. HOMANS, *Isis* 24, 456-67, 1936.

44. — HISTORY OF CIVILIZATION

(*General history, historical methods, biography and chronology*)

Haselden, R. B. Scientific aids for the study of manuscripts. x+108 p., 16b fig. Oxford University Press, 1935. ISIS

Elaborate study of the scientific aids which the modern palaeographer should be trained to use : illuminants and light filters, microscopes and magnifiers, ultraviolet lamps and fluorescent substances, photography of various kinds (photomicrography, ultra-violet, infra-red, Röntgen ray), measuring instruments. The account of each method is clear and practical. Various examples illustrate the value of these methods. Two introductory chapters explain the study of MSS in general and their care and handling. The methods of preservation used in the Huntington Library of San Marino under the author's guidance, should encourage private owners of MSS to donate these to that library. MSS in private hands are always in jeopardy. This is a very valuable addition to palaeographical literature. G. S.

46. — HISTORY OF LANGUAGE, WRITING AND LITERATURE

Favaro, Giuseppe. Corso di conversazione latina scientifica alla R. Università di Modena. *Isis* 24, 433, 1936. ISIS

Paget, Sir Richard. Sign language as a form of speech. *Nature* 137, 384-88, 3 fig., 1936. ISIS

VII. — MEDICINE

50. — HISTORY, ORGANIZATION, AND PHILOSOPHY OF MEDICINE

Goldwater, Leonard J. From HIPPOCRATES to RAMAZZINI. Early history of industrial medicine. *Annals of medical history* 8, 27-35, 1936. ISIS

Hume, Edgar Erskine. The centennial of the world's largest medical library : the Army medical library of Washington, founded 1836. *The military surgeon*, 78, 241-67, 1936. ISIS

Excellent historical account, well illustrated, by the present librarian. Fine appreciation of the work of JOHN SHAW BILLINGS (1838-1913) who developed the library in its present form and inaugurated its great *Index catalogue*. Good account of the growth and scope of the library, and of the men associated with it. It now contains nearly a million volumes, and the 4th series of the Index catalogue will begin this year. C. D. L.

Leaman, William G., jr. The history of electrocardiography. *Annals of medical history* 8, 113-17, 1936. ISIS

(Medicine history, Madrid congress, 1935). The Xth historical medical congress in Madrid and its significance for the propagation

of the study of the history of medicine by M. A. VAN ANDEL, *Janus* 39, 203-06, 1935. Dixième congrès international d'histoire de la médecine (Madrid 22-29 septembre 1935), by M. LAIGNEL-LAVASTINE, *Archeion* 17, 438-39, 1935 (received April 1936). ISIS

Montalenti, Giuseppe. L'accademia di storia dell'arte sanitaria e il suo museo. *Archeion* 17, 413-19, 5 fig., 1935 (received April 1936). ISIS

Description of the medico-historical museum in Rome. G. S.

Pessoa, Alberto. Emblèmes et figurations de la médecine à l'Université de Coimbra. Actes, conférences et communications du III[e] congrès international d'histoire des sciences tenu au Portugal en 1934, 4 p., 8 fig., Lisbonne, 1936. ISIS

Shryock, Richard H. Medical sources and the social historian. *American historical review* 41, 458-73, 1936. ISIS

Sigerist, Henry E. The historical aspect of art and medicine. *Bulletin of the Institute of the history of medicine* 4, 271-97, 27 fig., 1936. ISIS

Van Patten, Nathan. The medical literature of Mexico and central America. *Papers of the bibliographical society of America* 24, 150-99, 1930. ISIS

51. — EPIDEMIOLOGY, HISTORY OF SPECIAL DISEASES, PUBLIC HEALTH AND SOCIAL MEDICINE

Fowler, W. M. Chlorosis—an obituary. *Annals of medical history* 8, 168-77, 4 fig., 1936. ISIS

Riesman, David. Deceased diseases. *Annals of medical history* 8, 160-67, 1936. ISIS

Sand, René. Health and human progress : an essay in sociological medicine. Translated from the author's revised French text by C. F. MARSHALL. x+278 p. London, KEGAN PAUL, 1935. ISIS

Reviewed by J. B. O., *Nature* 137, 339, 1936.

52. — HISTORY OF HOSPITALS, OF MEDICAL TEACHING, AND OF THE MEDICAL PROFESSION. BALNEOLOGY, MEDICAL GEOGRAPHY

Kilduffe, Robert A. High lights in the history of hospitals. *Medical life* 43, 9-24, 1936. ISIS

Olcott, Charles T. The pathological cabinet of the New York hospital. *Annals of medical history* 8, 54-64, 9 fig., 1936. ISIS

VIII. — EDUCATION

(The methods of accumulating, imparting and diffusing knowledge)

56. — BIBLIOGRAPHY

(*Methods, libraries*)

Gabrieli, Giuseppe. Bibliografia degli studi orientalistici in Italia dal 1912 al 1934. Raccolta, con introduzione storica. XLVIII+169 p. In occasione del XIX Congresso internazionale degli orientalisti in Roma, Settembre 1935. ISIS

58. — CATALOGUES OF SECOND-HAND BOOKS ON THE HISTORY AND PHILOSOPHY OF SCIENCE

Many catalogues of second-hand books are so interesting and so full of valuable information that we shall henceforth register them in this section, together with other lists of a similar nature, such as catalogues of scientific medals and prints. When applying to the publishers of these catalogues for a copy, please mention *Isis*.

Dörling, F. Alte Naturwissenschaften und ihre Geschichte, neuere chemische Literatur. Auktion 53, 80 p., 881 items. Hamburg 1, Speersort 22, 1936. ISIS

Fock, Gustav. Geschichte der Medizin und Naturwissenschaften, Antiquariatskatalog Nr. 685. 74 p., 1753 items. Leipzig, C 1, Schlossgasse 7-9. ISIS

Quaritch, Bernard. A catalogue of books on systematic botany, plant biology, cryptogamic botany, including the library of the late OTTO VERNON DARBISHIRE. No. 518, 40 p., 571 items. London, W. 1, 11 Grafton St., New Bond St., 1936. ISIS

59. — MEMORIA TECHNICA

Critical bibliography no. 47. *Isis*, vol. 26, 244-298 1936. ISIS

This note is published at the end of our bibliography solely for the convenience of the scholars who cut out the whole or part of it, attach extracts to catalogue cards and classify them. By adding this note to the others they will be able to find out rapidly whether this particular bibliography has been analyzed or not.

Isis no. 68 (vol. 24, 2, 305 p., 12 fig.) Bruges, 1936. ISIS

This number is analyzed in the 47th Critical Bibliography. Every previous number has been analyzed in previous bibliographies. G. S.

Index of Authors Included in the Forty-seventh Bibliography

The Roman figures followed by (1) or (2) refer to the centurial classification (Part I). Thus, Abel, A., XI(1) means that a paper by Abel is listed under eleventh century, first half.

The Arabic figures refer to the historical and to the systematic classification (Parts II and III) which are subdivided in sections numbered consecutively from 1 to 60. For instance, Alt, A., 12 indicates that a paper by Alt is listed in section 12 (Israel); Corlett, W. T., 40 indicates that a paper by Corlett is listed in section 40 (Ethnology).

May 1936. FRANCES SIEGEL.

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